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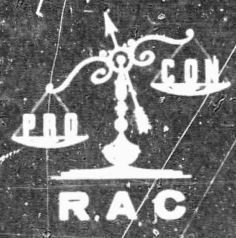
TECHNICAL
MEMORANDUM
RAC-T-487(FGE)

OCTOBER 1956

RESEARCH ANALYSIS CORPORATION

A Prescribed Load List Policy for Seventh Army

by
Lee G. Wentling Jr
Roland G. Ruppenthal



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SUBJECT: RAC-T-487, "A prescribed Load List Policy for Seventh Army"


TO:

1. Transmitted for your information and retention is (are) _____ copy (copies) of RAC-T-487, "A Prescribed Load List Policy for Seventh Army".

2. This document was prepared by the Research Analysis Corporation Field Office, Europe (RACFOE) in fulfillment of the objective of a study on repair parts supply in the Seventh Army. This study focuses on the requirements for a uniform policy on the Prescribed Load List (PLL) and the organizational stockage of repair parts that would maximize combat readiness. The study has included examination of DA and USAREUR PLL policies, an analysis of demand experience and of data on stockage composition, an examination of alternative policies with respect to stockage criteria and the inclusion of prescribed items, and of the implications of such policies with respect to feasibility and combat readiness. Although based upon Seventh Army operations, it may be of value to other theaters and commands. The contents of the report, including the findings and solutions, represent the view of RACFOE, and are not official Department of Army position.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

1 Incl
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RAC FIELD OFFICE (EUROPE)
TECHNICAL MEMORANDUM RAC-T-487(FOE)
Published October 1966

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RESEARCH ANALYSIS CORPORATION

MCLEAN, VIRGINIA

Received for Publication 2 August 1966
Published October 1966
by
RESEARCH ANALYSIS CORPORATION
McLean, Virginia

FOREWORD

The main function of the Research Analysis Corporation Field Office, Europe (RACFOE), is to undertake analytical studies of problems of interest to the Commanding General, Seventh Army, to provide a scientific basis for decision on actions to improve military operations.

This report was prepared in partial fulfillment of the objectives of Research Project 7, "Repair Parts Supply in the Seventh Army," which were "to analyze the repair parts supply system in the Seventh Army, to investigate reported shortages, to determine their causes, and to recommend measures to remedy deficiencies." The study was undertaken at the request of the G4.

In the course of the analysis it was requested that the study focus on the immediate requirement for a uniform policy on the Prescribed Load List (PLL) and the organizational stockage of repair parts that would maximize combat readiness. This paper is in response thereto. It includes an examination of Department of the Army and United States Army, Europe PLL policies; an analysis of demand experience and of data on stockage composition; and an examination of alternative policies with respect to stockage criteria and the inclusion of prescribed items and of the implications of such policies with respect to feasibility and combat readiness.

Roland G. Ruppenthal, Director
RAC Field Office, Europe

ACKNOWLEDGMENTS

The authors received both assistance and encouragement from numerous sources in the course of this study. Thanks are due several members of the office of the G4, under whose sponsorship the study was conducted. Col Carl Bronn, G4 during the early phases of the study and originator of the study; his successor, Brig Gen William T. Bradley; and Col William O. Gall, Deputy G4, all gave unstinting support to the effort. Useful guidance on almost a day-to-day basis was provided by Col Frederic C. Bott, Chief, Supply Division, and Lt Col Harold K. Baer, project advisor. Maj Arthur Schultz and Capt Billy J. Williams likewise gave generously of their time.

In the Comptroller's office Lt Col Leonard M. Winter arranged for local data processing support, and 1st Lt Robert J. Colonna suggested and assisted in the development of the stockage process model employed in the analysis.

The bulk of the data used was generously provided by the 3d Infantry Division. Particularly helpful in the collection of these data were Lt Col James L. Thayer, G4, and CWO Charles W. Owens, also of the G4 Section.

The authors also benefited greatly from discussions with other members of the RAC/McLean staff with experience in the repair parts field. Mr. Harrison N. Hoppes and Mr. John R. Bossenga gave invaluable advice and outstanding support in the processing of data tailored to the requirements of the study. Finally, Miss Lyle Kincheloe, Field Office Secretary, in addition to performing the normal duties in producing a finished manuscript, eased the authors' burden by assisting in the laborious task of hand processing raw data from machine print-outs.

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Problem

To recommend a uniform Seventh Army policy on the Prescribed Load List (PLL) and the organizational stockage of repair parts that will maximize combat readiness.

Facts

The supply of repair parts in the Seventh Army is widely acknowledged to be deficient. The inadequacy can be attributed partly to an overall shortage of repair parts within United States Army, Europe (USAREUR), and partly to the lack of uniform supply policies and to wide variations in practices and procedures. The latter are particularly evident in the wide differences in the make-up and management of PLLs of like units, the poor performance of units in matching stockage to demand and in satisfying demand, and the fact that units are not recording demands accurately or completely. These characteristics obtain despite the application of policy that is generally consistent with the directives of higher headquarters.

It was natural to presume a relation between this situation and the failure of units to meet assigned readiness criteria with respect to parts stockage and equipment availability. At the request of the G4, Seventh Army, the initial analysis has concentrated on the organizational level on the assumption that an understanding of the mechanism of parts usage and resulting demand is prerequisite to an understanding of the requirements made of that system and to the development of policies and procedures that can best meet those requirements.

Discussion

The study, in brief, has included an examination of DA and USAREUR PLL policies in the light of the stated intent and objectives with respect to repair-parts stockage at the organizational level; the acquisition and analysis of data on demand and on stockage composition; the measurement of supply performance at unit level; and an examination of alternative policies with respect to stockage criteria and the inclusion of prescribed items, including their feasibility and readiness implications.

SUMMARY

One of the major tasks was to determine the characteristics of existing PLLs in terms of size and composition, the nature of demands, the degree of demand accommodation and demand satisfaction (i.e., the extent to which stockage matches demand and to which demands are satisfied), turnover rate, and efficiency. The depth of this analysis was determined in part by the availability of data. Basically two sets of data were acquired for this purpose: PLL characteristics in terms of size, composition, and the incidence of zero balances were determined primarily from data that the Seventh Army G4 collected from about 80 units in the two corps. Analysis of demand characteristics, in terms of number and frequency, the quantities of active stock numbers involved, commonality of usage among units, the quality of the list as reflected in demand accommodation and demand satisfaction, and the implications of increasing demand accommodation, was made possible by the acquisition of the demand experience of 13 battalions, collected by the 3d Inf Div (Mech) and processed by the RAC/McLean staff.

Three features of the repair-parts supply system emerged from the initial analysis and had an important influence on the study's eventual findings: (1) the extreme variation in PLL size and composition, and in local stockage policy, with their potential implications for readiness; (2) the significance of the fact of the intended dual function of the PLL as contrasted with the attitude and actual practice with respect to the various components of the PLL; and (3) the apparent equivocation at various echelons on the imposition and enforcement of a uniform PLL policy, notably with respect to prescribed items.

The first of these is traceable in large part to the permissive policy under which the choice on stockage has in effect been delegated from the Department of the Army (DA) all the way to the unit. The result has been tremendous variation in PLL size and makeup and certain, if not precisely measurable, effects on combat readiness.

The second feature stems directly from the dual-purpose function of the PLL and the relation of the prescribed-items component to the demand-supported component. The dual role of repair-parts stockage lies in the requirement that it sustain the unit during initial stages of combat when normal supply support may be interrupted, and that it provide immediate access to frequently-used parts required for peacetime maintenance. Use of the PLL as a working stock compromises its performance in the first role, since it will normally be at reduced or at zero balance in many lines.

The dual function of the prescribed load implies a natural dichotomy in the categories of stockage, and there has been a tendency to lose sight of the distinction between those initial-stockage items that qualify for increased stockage in peacetime on the basis of demand and the remaining stockage items, also selected from the prescribed-items list. This is not surprising because the stockage of the latter has been optional as long as they do not meet demand-supported criteria. As a result demand-supported stockage has become the primary category of stockage. This trend has also been encouraged by doubts as to the value of prescribed items, since there is no experi-

ential data from combat that will attest to their usefulness as there is peacetime data in the case of demand-supported items. The end result has been a distortion, if not a complete reversal, in the original concept of roles. The concept of the role of prescribed items, in other words, has been submerged in the emphasis on the demand-supported component of the PLL.

The reluctance of higher command echelons to require conformance with a prescribed PLL policy has been characteristic of recent repair-parts-supply history. Whether this represents lack of confidence in the efficacy of the policy or unwillingness to restrict the freedom of action of lower commands is not known. Until recently DA regulations left no doubt as to their intent with respect to the stockage of prescribed items. The most recent issue of AR 735-35,¹ however, breaks with former policy and makes adherence to mandatory stockage optional, at the same time affirming the basic concept of mandatory stockage and of the role of prescribed items. USAREUR regulations for a time left the decision to major subordinate commands, then for a short period made stockage mandatory, and later rescinded the directive, reverting to the earlier policy.

In light of the above, it was clear that the central issue to be resolved was whether the potential value of prescribed items was great enough to warrant stockage independent of their qualification on a peacetime, demand-supported basis. Although direct evidence on the efficacy of prescribed items in combat was not at hand, relevant data were available on peacetime usage to answer the question regarding the validity of the concept of mandatory stockage of such items.

Finally a simplified model of the stockage process was devised and used in conjunction with the available demand data from the 3d Inf Div to compare major alternative-policy choices on PLL with respect to resulting size, make-up, demand accommodation, turnover rate, and efficiency, that were open to the Seventh Army. A peripheral but not insignificant issue, viz, the relation of selected policy and practices to the periodic readiness-condition (REDCON) rating, has also been examined to determine the implications for repair-parts-supply management at the unit level.

Conclusions

1. The adoption of mandatory stockage of prescribed items for mission-essential end items and the use of Seventh Army stockage criteria in the selection of demand-supported peacetime-augmentation items would provide maximum demand accommodation and stability in the PLL and the highest probability of fulfilling the dual function of the PLL and maximizing its contribution to combat readiness.

Implementation of the recommended policy would result in varying increases in the size of PLLs. The PLL of a mechanized-infantry battalion, for example, would be about 1400 items.

SUMMARY

Mandatory stockage could be expected to result in considerable improvement in demand accommodation—i.e., the match of stockage to demand. Demands can be satisfied only to the extent that items demanded are on the stockage list and on hand. It is important that demand accommodation be high, therefore, because it represents the upper bound to the satisfaction of demands.

The efficiency of the resulting PLL (in terms of maximum accommodation attainable with the list of that size) would be slightly less than with a PLL based solely on demand-supported stockage. This is to be expected with a PLL, selection of the items for which is based on estimated combat requirements in addition to peacetime usage.

The value of the prescribed-items component is to be noted especially in cases where demands are not adequately recorded. Poor demand accommodation inevitably accompanies incomplete recording of demands. The presence of prescribed items helps offset such loss in demand accommodation, guaranteeing a minimum accommodation in peacetime.

The adoption of mandatory stockage of prescribed items will also introduce uniformity in like TOE unit PLLs, and thus facilitate review and management at unit and higher levels, reducing turnover by about one-third, since stockage of prescribed items increases stability.

Selection of the appropriate stockage criteria is essentially a matter of economics—viz, determining whether the resulting increment in demand accommodation is commensurate with the increment in stockage relative to the stockage required to accommodate all demands. Use of the Seventh Army retention criterion (i.e., 1 demand per 180 days) results in an increase of 6 percent at a cost of only 2 percent and is therefore justified.

2. A permissive policy that results in the exclusion of any prescribed items from the PLL cannot produce a peacetime-demand accommodation greater than that under a policy of mandatory stockage and cannot ensure maximized combat readiness.

3. The mission-essential repair-parts category could be eliminated without significant reduction in combat readiness, assuming stockage of prescribed items to be mandatory and recording of demands to be improved.

Control of this category has been inadequate and its use abused. There is evidence that units have added indiscriminately to this component as a substitution for proper PLL management and that it has also been resorted to as a device to improve the readiness rating. An alternative to elimination is the purge of PLLs of all such items except those qualifying for the PLL under other criteria and the institution of more rigid controls.

4. The REDCON rating criteria, combined with the pressures associated with achieving the highest possible readiness rating, are incompatible with good PLL policy and parts-stockage practice.

The REDCON rating, which is essentially a reflection of the percentage of PLL items at zero balance, discourages good PLL policy and supply performance and, indeed, even permits the concealment of poor performance. Units with relatively unresponsive PLLs (i.e., low demand accommodation) actually have better prospects of achieving a good rating than do units with high demand accommodation. The REDCON

reporting system invites the padding of the PLL with inactive items, restriction on the issue of parts for routine maintenance (particularly as the reporting date approaches), acceptance of a low-quality list, and even the deletion of prescribed items when stock is not available and replenishment appears remote. In short, it emphasizes readiness reporting at the expense of true readiness and provides no incentive for improving the quality of the PLL.

There is need for reforming the REDCON reporting criteria to provide a true measure of readiness, disclose deficiencies, and also provide incentives for better performance.

5. The stockage of all items on the PLL should continue to be a minimum quantity of two.

This is clearly the intent of DA regulations, with which Seventh Army practice is consistent. Its desirability and validity is substantiated by independent analysis, which reveals that a minimum stockage of less than two would double the proportion of demands equal to or exceeding the authorized quantity and thus increase the number of items at zero balance.

6. The initial authorized stockage quantity for items applying to more than one end item should be computed according to DA Regulation 735-35¹ rather than Seventh Army instructions if mandatory stockage of prescribed items is adopted.

Use of the DA-prescribed method results in a negligible reduction in the number of lines stocked, but about a 7 percent increase in the number of parts. Computation is simpler and results in some improvement in readiness.

Recommendations

It is recommended that Seventh Army

1. Adopt the policy of mandatory stockage of the prescribed items qualifying for initial stockage in the unit.

2. Continue use of the present stockage criteria for the selection and retention of the demand-supported augmentation component of the PLL.

3. Eliminate the mission-essential repair parts category or purge mission-essential parts from current PLLs and institute a strict control over the use of this category.

4. Stock all items in a minimum quantity of two.

5. Compute initial authorized stockage quantities for items that apply to more than one end item according to the instructions in AR 735-35.¹

6. Consider the following as possible remedies to the deficiencies inherent in the REDCON reporting system:

a. Use the overall percentage of requests that are immediately filled from unit stockage as a measure of performance.

SUMMARY

This percentage reflects both PLL accommodation and average stock balances on hand and is the most direct measure of the unit supply section's performance. The data for this figure could be collected on a simple tally sheet kept by the stock clerk or by notations on the transaction register. The percentages would be computed monthly and consolidated quarterly for use in the readiness report.

b. Establish a special-purpose prescribed load of parts aside from the normal working stock, reserved exclusively for use in combat. Such loads are in fact already authorized by AR 735-35,¹ and the readiness criteria now in use could be appropriately used in evaluating their status.

7. Undertake a comprehensive periodic review of prescribed items listings with the objective of identifying candidates for addition and deletion.

Such an updating would best be accomplished at the Inventory Control Center (ICC) by matching a consolidated list of Seventh Army's prescribed items against the ICC stock list and fringe file.

8. Continue its support of efforts to implement the concept of centralized management of stockage lists [both Authorized Stockage Lists (ASLs) and PLLs], like the program now in progress at the 3d Inf Div.

**A Prescribed Load List Policy
for Seventh Army**

ABBREVIATIONS

AFSCS	Army Field Stock Control System
ASL	Authorized Stockage List
COMMZ	communications zone
CSMI Team	Command Supply Maintenance Inspection (Team)
DA	Department of the Army
DATM	Department of the Army Technical Manual
DSSA	Direct Supply Support Activity
DSU	direct-support unit
EAM	Electronic Accounting Machine
FSN	Federal stock number
ICC	Inventory Control Center (Seventh Army)
ICP	Inventory Control Point (COMMZ)
PLL	prescribed load list
REDCAPE	readiness capability
REDCON	readiness condition
ROAD	Reorganization Objective Army Division
TAERS	The Army Equipment Records System
TM	technical manual
TOE	table of organization and equipment
USAREUR	United States Army, Europe

Chapter 1

PURPOSE, COMPOSITION, AND MAINTENANCE OF THE PRESCRIBED LOAD LIST

INTRODUCTION

This technical memorandum is in partial fulfillment of RAC Field Office, Europe, (RACFOE) Project 7, dealing with the repair-parts supply system of the Seventh Army. The initial effort in the study has been exerted exclusively at the organizational level, since an understanding of the mechanism of parts usage and the resulting demand is essential to an understanding of the requirements placed on the system that must respond to these demands.

There are currently many different practices under existing policies in dealing with the Prescribed Load List (PLL) in Seventh Army. This situation has led to wide variation in the composition of repair-parts stockage and undoubtedly to corresponding variations in unit readiness. The objective of the study is to recommend a uniform Seventh Army PLL policy leading to the organizational stockage of parts that will permit units to achieve maximum combat readiness. Existing policies have been examined, data accumulated and analyzed, alternative policies defined and evaluated, and preferred policy-and-implementation procedures recommended. Particular emphasis has been given to the status of prescribed items and to the most appropriate means of generating and maintaining the organizational PLL.

PURPOSE OF THE PRESCRIBED LOAD LIST

Before discussing the purpose or makeup of the PLL it is well to note the purpose of the repair parts themselves as distinguished from the list. Unit repair-parts stockage has a dual function: its primary role is to sustain the unit during the initial phase of combat when contact with its supporting Direct Support Supply Activity (DSSA) may be temporarily interrupted; its secondary role is to provide immediate access to frequently used parts and related items required in the conduct of peacetime unit maintenance. When a single prescribed load is carried, the secondary function compromises the performance of the primary one, since a working stock normally will be at reduced or zero balance in a portion of the lines as a natural condition. This is particularly true at unit level, where there is no safety level and where the replenishment time is

assumed to be zero, whereas in fact the supporting DSSA may have several days' backlog of unit requests on hand when a request is submitted. The peacetime availability of repair parts of course directly contributes to the combat readiness of the unit by reducing the waiting time in the maintenance facility and generally increasing the availability of equipment. In a smoothly functioning system the compromise in combat readiness involved in relying on the same stockage for peacetime maintenance can be small, but in the situation of slow resupply that currently exists in Seventh Army a considerable portion of the prescribed load will be at zero balance at all times. Such a situation argues for the use of a special-purpose load that is not required to function as a working stock. Provision for this practice is specifically made in the regulations and is authorized at the discretion of the major commander. Both functions of the prescribed load are directed at achieving maximum combat readiness of the unit. The first attempts to meet predicted requirements to sustain equipment that fails in combat, and the second attempts to ensure that the maximum number of equipments are in a combat-ready state at all times. Use of a single prescribed load involves a compromise that is not significant during periods of plentiful supply but that may assume serious proportions when conditions interrupt the smooth flow of parts in the system.

The purpose of the PLL itself is to list those repair parts that should be carried in the unit to best achieve the dual function of the prescribed load. It is important to recognize that the PLL is not a static list that can be prepared and forgotten. It is a dynamic document that requires continual review and revision to be responsive to the needs of the unit. The PLL, along with the associated supply actions needed to acquire the indicated stockage, constitutes an adaptive process whose objective is to maintain a high state of materiel readiness through adequate accommodation of peacetime demand and the provision of parts that will be needed in combat.

The dual function of the prescribed load implies a natural dichotomy in the categories of stockage of which it is composed. This dichotomy is reflected in the existence of an initial prescribed stockage of parts for each end item, selected on the basis of estimated combat requirements; a peacetime increase in the authorized quantities thereof where supported by sufficient demand; and the addition of other repair parts that qualify on the basis of specified demand criteria and are authorized for replacement at unit level (generally referred to as "augmentation items" in this paper). Proper maintenance of the PLL enables the stockage at unit level to be responsive to the requirements of the unit, which fluctuate with season and with the age distribution of the unit's equipments. The prescribed items are selected at DA level and are listed in appropriate technical manuals, whereas the unit is currently responsible for increases in stockage quantities of prescribed items and additions to the list that reflect local conditions and policies. The primary means by which such increases in quantities and augmentations to the list are made is the accumulation and analysis of the demand experience within the unit. Such data must be reviewed frequently if the PLL is to be kept up to date and responsive to need. All of this is to no avail unless the unit also expeditiously accomplishes the actions necessary to acquire the parts and keep them on hand, and unless the supply system in general is able to provide the necessary quantities of parts. The starting point is the PLL, however, since neither skill in requisitioning, storage, and issue nor

a plentiful supply of parts can achieve the objectives of unit stockage unless the appropriate parts are requisitioned.

PREScribed LOAD LIST STOCKAGE CATEGORIES

The repair parts and maintenance-related items that appear on the PLL may fall into one of four categories for units of Seventh Army--prescribed items, demand-supported repair parts, concurrent repair parts, and mission-essential repair parts. These categories are discussed in some detail here and are also defined in App A.

Prescribed Items

In accordance with the DA regulation, the backbone of the unit PLL is the list of initial-stockage items selected from the prescribed items in the technical manuals. There is a minor distinction between the totality of prescribed items for the equipment of the unit and the initial stockage for that unit. A prescribed item has a quantitative allowance that is a function of the end-item density in the unit. In some cases a prescribed item will not qualify for initial stockage because of low end-item density. This occurrence will generally be restricted to those items that are classified as high-mortality items, which are not necessarily functional repair parts (i.e., parts essential to the performance of the end item's operational mission). Those items now designated in the technical manuals as combat essential are intended to be functional repair parts. Virtually all of these are authorized for initial stockage independent of end-item density, although the quantity prescribed may increase as the density of the end item.

The initial stockage selected from the prescribed items constitutes a basic PLL that is virtually identical for all units organized under the same table of organization and equipment (TOE). Variations will occur as a result of different makes and models of certain equipments that are on hand under a given basic line-item number. Engineer items frequently fall into this category, with generators constituting a notorious example. This category defines a minimum set of repair parts and minimum stock level of each for any unit as a function of the end items supported by the unit. The items in this basic PLL are selected at DA level on the basis of estimated combat requirements and should retain their identity as initial stockage items at all times together with the minimum authorized-retention quantity. Even this list is not static. Additions to, deletions from, and changes in the density of end items supported by the unit can result in changes in the makeup of the list and in the minimum-stockage quantity. Demand experience can result in an increase in the authorized-stockage level above that defined in the technical manual.

The intent with regard to this category of stockage is clearly stated in Sec I of TM 9-2300-223-20P.² It is appropriate to call attention to some of the salient provisions thereof regarding this component of the PLL. The manual specifies, for example, that prescribed loads, containing organizational maintenance allowances for a 15-day period for the major items supported, must be on hand or on order at all times. It authorizes increases in quantity for all items when justified by demand and usage experience but specifically prohibits

reductions in stated quantities of "combat-essential" items. (Although published in July 1965, the manual's nomenclature is not current, for it still refers to "combat-essential" items, a category apparently being discontinued.) It specifies that no changes in the composition of the list will be made as long as the end items are not changed, except as recommended to and approved by the responsible materiel agency. Finally it authorizes major commanders to determine the number of prescribed loads units will carry.

This initial stockage constitutes a component of the PLL that will be common to all units of the same TOE and provides a means of determining the comparative adequacy of the prescribed items in a group of like units. It is clearly intended that these items retain their separate identity even though their use might satisfy the criteria established for the demand-supported peacetime augmentation of the initial stockage list. The purpose of collecting demand data on these items is to adjust the stockage quantity, not to convert them to the demand-supported category of stockage.

DA Regulation AR 700-18³ substantiates the status accorded the combat-essential items in the aforementioned TM. Reference is made to all items having a quantitative allowance specified in the technical manuals. These are designated in this report as prescribed items and include the former category of combat-essential and the high-mortality items. In directing the preparation of the repair-parts list in the technical manuals, AR 700-18³ states that "... the guidance in each organizational repair parts manual will be clear that quantities as indicated in the equipment density columns are authorized and are required to be stocked by the organization."

A further point made in this regulation concerns the initial selection and subsequent revision of the list of items designated for initial and continued stockage. Mortality data form the basis for the selection of repair parts for initial stockage at the unit. That refinement in this selection and updating and maintenance of the list were intended, in a fashion analogous to that at lower echelons, is made explicit in the following quotation from the regulation:

Repair parts mortality initially will be estimated by use of anticipated consumption frequency under combat conditions. All available data such as manufacturer's recommendations, engineering, service and troop tests results, failure data reports, and experience with other similar items will be taken into consideration. Continual refinement of repair parts mortality will be made by collecting and analyzing data from all sources available such as failure data reports, supply demand experience, data developed under the Army Field Stock Control System (AFSCS), user experience, Equipment Improvement Reports, and the Army Equipment Records System (TAERS)

As indicated, the sources used for repair-parts selection are essentially the same as those used in the updating of mortality data.

The initial stockage list is no more a static document than the unit PLL or the ASL of a direct-support unit (DSU). Although responsibility for maintenance of the prescribed-items list is centered at the commodity command, it clearly extends down to the user level, and each technical manual listing authorized organizational stockage solicits suggestions for revision to the list and identifies the agency to be contacted.

The preceding material extracted from DA regulations and manuals is straightforward and unequivocal and expresses DA policy regarding the

prescribed load for a considerable period before publication of the October 1965 edition of AR 735-35.¹ This edition retains the language of TM 9-2300-223-20P² with regard to stockage of the initial-stockage items but adds one proviso that can completely reverse the status of the initial stockage items. The regulation now states that major commanders may authorize the deletion of initial-stockage items that do not also meet the established criteria for stockage on a demand-supported basis. This statement constitutes a major change in DA policy with regard to the composition of the PLL. In effect a major commander who issues this authority to the units in his command, delegates the responsibility for the determination of the PLL composition to the lowest possible level and establishes conditions under which wide variation in PLL size and composition can occur.

Seventh Army has had considerable experience in operating under this policy. Since 1964, except for the period January-May 1965, stockage of combat-essential items that are not also demand-qualified has been optional. The implications of this kind of policy are considered in some detail elsewhere in this report and cast doubt on the practicability of such a permissive policy. The choice of reliance strictly on demand experience for stockage is available to the unit commander, and it is not clear that he will have the experience and knowledge necessary to successfully determine his requirements for combat on this basis, particularly in view of the probable skill of the personnel on whom he must rely in accumulating and analyzing the required data. In any event a permissive policy is an invitation to anarchy and may be virtually equivalent to no policy at all.

Demand-Supported Repair Parts

Demand-supported repair parts and maintenance-related items constitute the peacetime augmentation to the initial stockage insofar as the range of items stocked is concerned. Other peacetime additions consist of increases in the authorized quantities of initial stockage items as dictated by usage. The demand-supported component of stockage in a specific unit PLL may include any item that is authorized for replacement or use at the organizational maintenance levels. Thus the part may be either a prescribed item that did not qualify for inclusion in the initial stockage or an "as-required" item identified in the technical manual for the end item by a listing with an asterisk in the allowance column.

In the context of the present policy within Seventh Army, there has been a tendency to lose sight of the distinction between those initial-stockage items that qualify for increased stockage in peacetime on the basis of demand and the remaining initial-stockage items, also selected from the prescribed-items list. This is understandable because the stockage of the latter is optional as long as they do not meet the criteria for demand-supported stockage. The result is a situation in which some initial-stockage items are moving into and out of the PLL as a result of the normal fluctuation in demand. At present the primary category of stockage must be considered to be the demand-supported items, and there is no particular reason to identify the items that also qualify for initial stockage.

This situation has also led to some confusion with respect to mobility requirements. A unit may or may not be capable of transporting its PLL stocks

because of the presence of numerous or bulky items that are demand-supported but not necessarily functional—i.e., essential to the performance of the combat mission of the end item to which they apply. In fact there may be no requirement to carry many of these items, since only the initial-stockage items are required by regulation to be carried at all times. The resulting picture of the ability of a unit to carry its basic prescribed load of repair parts and maintenance-related items may be a false one. Unfortunately there may be no simple means to evaluate the status of PLL stockage mobility because the true category of an item is not readily identifiable. A PLL may be labeled as not mobile through the application of standards more stringent than intended in the regulations, since the requirement for mobility may be based on the inclusion of a larger group of repair parts than was originally intended—i.e., peacetime augmentation items with no real requirement for mobility. This problem is in fact further aggravated in Seventh Army by the existence of an additional category of stockage, which is discussed in the following paragraph.

Concurrent Repair Parts

New equipment normally is issued with a specified allotment of concurrent repair parts, or concurrent spares, both the range and quantity of which are designated by the materiel command responsible for the end item. Parts remain in this category only temporarily. At the end of one year's experience with the new equipment the unit is required to transfer these parts to another category of stockage or delete them from stockage as appropriate. A given part may of course be retained if listed as a prescribed item or if it has qualified as a demand-supported item. During the first year of experience, however, no decrease in the range or quantities of concurrent repair parts is authorized, although the stockage quantity may be adjusted upward if indicated by demand experience.

Mission-Essential Repair Parts

This category of stockage appears to be peculiar to Seventh Army because it is not mentioned in appropriate DA publications. As applied by Seventh Army at unit level, this category covers items that are considered essential to the mission of the unit by its commander but are not authorized for stockage under any of the three "official" categories just discussed. At DSU level this category is defined quite differently. There mission-essential repair parts comprise those parts in the PLLs of supported units that are not demand supported at the DSU and all combat-essential repair parts listed in the 30P, 40P, and 35P series technical manuals for end items supported by the DSU. The mission-essential category requires consideration because it has become a very sizable component of the PLL in many units. As will be shown, there are units that stock as many as 400 different repair parts under this category, which may account for almost 50 percent of the items on the PLL. On the other hand there are units that do not utilize this category at all. If nothing else, the existence of this category makes a major contribution to the variability of PLL composition that has been plaguing the system in Seventh Army.*

*A distinction is made between mission-essential repair parts and mission-essential end items in this report and should be kept in mind.

The unit commander may add any item authorized for organizational replacement or use and may even obtain special authorization to stock an item normally restricted to use at higher maintenance echelons. Current Seventh Army regulations require that the unit commander desiring to stock an item as mission-essential request approval from the supporting DSSA. The normal authorized stockage quantity for such an item is one, and approval for such stockage may be granted at the DSSA level. Requests for items not listed for organizational use in the technical manuals, and requests for stockage quantities in excess of one, must be submitted to Headquarters, Seventh Army. A further requirement with regard to this category is that authorization for stockage be renewed annually and that the unit initiate such action. Current authorization for the stockage of each mission-essential part constitutes part of the documentation required in support of the unit PLL.

Originally it was probably intended that a very limited number of items be stocked at the unit level to cover local conditions or unique missions not specifically recognized in the basic regulations. The provisions requiring justification by the unit commander and approval by a higher echelon were obviously intended to control and restrict stockage in the mission-essential category to a relatively few items. Since many units stock several hundred items in this category, it is clear that in practice these controls have not been effective and that supervision of the category by the DSSAs has been lax.

FORMATION AND MAINTENANCE OF THE PRESCRIBED LOAD LIST

To this point little has been said about the procedures involved in the formation and proper maintenance of the PLL. This is a complex process and one that has caused a great deal of difficulty in most Seventh Army units. It is appropriate to trace the development of the PLL in a unit from the generation of the initial stockage list through its evolution into a mature PLL that has been in operation for some years. No effort is made to reproduce the detailed procedures, which are spelled out in AR 735-35.¹

In a newly-formed unit the construction of the initial stockage list is quite straightforward. A list of major equipments, including the density of each, is prepared and the technical manuals applicable to each are assembled. From the manuals a sublist is prepared for each end item of those prescribed parts and maintenance-related items that qualify for initial stockage on the basis of the density of that end item supported by the unit. These sublists are then consolidated to produce the initial prescribed load for the unit. The consolidation process discloses those repair parts that have multiple end-item application and establishes the stockage quantity as the sum of the allowances for the individual end items. Considerable multiple application occurs in some areas, and in some cases consolidated repair-parts lists have been prepared by DA to cover many related end items. The consolidated tank-automotive parts list, TM 9-2300-223-20P,² is perhaps the best known example, and its use is explicitly directed in AR 735-35.¹

Once the initial PLL is completed, the necessary records set up, storage facilities established, and requests for parts submitted, the repair parts section of the unit is in business. Each demand levied by the first- and

second-echelon maintenance activities is now recorded and the data accumulation necessary for the further development of the PLL begins. A record of demands is part of the documentation for each item in the initial PLL file and serves to provide the information required to update the stockage quantity of items in the initial stockage of prescribed items. This component of the PLL is of a special nature since its elements are not subject to deletion unless there is a change in the listings in the technical manuals or unless the end item itself to which they apply is removed. During the first 6 months of operation of the section no change in the quantity of initial stockage items is authorized. Thereafter a monthly review is made to determine whether changes in the stockage quantity are required. These changes are restricted to increases, since the initial quantity to be carried is a specified minimum. The total quantity demanded in the previous six review periods is determined, and a table of stockage quantities is entered to select the authorized quantity. Any requirement disclosed by this review will be requested as a one-time, nonrecurring demand and excluded from the count of subsequent demands in later reviews. The objective is to base the stockage quantity solely on the frequency of demands directly resulting from maintenance actions.

The maintenance of the prescribed-item component of the PLL consists in adjustment of the stockage quantity. This quantity may fluctuate over a period of time but must never fall below that initially determined by reference to the technical manuals. The collection and analysis of demand data is not, however, restricted to those items in the initial prescribed load. A record of every demand is required by the regulation. An initial demand for an item that is not included in the PLL causes a record to be prepared for that Federal Stock Number (FSN) indicating the date and quantity demanded. This record is placed in a separate "fringe file." In this fashion a file is built up that contains all recurring demands for items not currently on the PLL. As the demand occurs it is entered on the record, if one exists, or a new record is prepared. When a demand occurs for a fringe item for which a record already exists, a review is made to determine if the new demand is the third that has occurred within the last 180 days. If three demands have been made against this item within six review periods, it qualifies for stockage as part of the PLL augmentation. The total quantity requested in the three demands is determined, and the authorized stockage quantity is obtained from a table in the regulation that expresses this as a function of the total quantity demanded and the period of time over which these demands accrued. Appropriate records are prepared, the item is entered on the PLL, and the supporting DSSA is notified of the addition to unit stockage.

Two requests are now prepared. The first is to satisfy the demand that has resulted from a maintenance action and has triggered the addition of the item to the unit PLL. This is a recurring demand and is so coded on the request. In addition a request is submitted to cover the initial quantity for a one-time requirement and is not made in response to a maintenance action. Once an item qualifies for augmentation stockage it is guaranteed at least six review periods (180 days) before it can be deleted.

Unlike the initial stockage, consisting of prescribed items with indefinite tenure, the augmentation component must remain active if it is to continue to qualify for stockage at the unit. Having achieved a place on the PLL of the unit,

these items now are subjected to review each 30 days for possible revision in the stockage quantity, and after the first 180 days for possible deletion so long as the equipments to which they apply have been active and they do not continue to qualify as seasonal items. Thus the augmentation items constitute the major dynamic component of the PLL. If the regulations are observed, there will be a continual turnover in these items, the magnitude of which is a function of the criteria applied in the qualification for stockage and retention. Within Seventh Army the stockage criterion for retention of an augmentation item is the occurrence of at least one demand each 180 days. Such an item is subject to deletion if a review discloses that there have been no demands in the last six review periods. The DA regulation contains a more stringent requirement for retention. Under AR 735-35¹ an item must continue to experience at least three demands each 180 days if it is to continue to qualify. In other words, in Seventh Army an item qualifies for admission to the PLL with three demands in 180 days and is deleted only if there are no demands in a like period, whereas under DA criteria an item qualifies for admission if it receives three demands and must be deleted if it receives less than three demands in 180 days. As might be expected the Seventh Army criteria lead to a greater number of items in the augmentation component as a steady-state condition, while the DA criteria lead to a higher turnover rate. A comparison of the results of applying these two criteria appears in Chap. 5.

Mention has been made of conditions under which an augmentation item is retained in the PLL even though it does not continue to qualify on the basis of strict interpretation of the criteria. Parts for equipment that has been inoperable during all or a major part of the previous 12 review periods are not to be deleted. Another condition that may permit the retention of an item is its classification as a seasonal item. Thus the deletion of an augmentation item is not automatic but requires the application of informed judgment when a review indicates failure to satisfy normal demand criteria. These conditions are simple to state in a regulation, but it is another matter to carry out the required analysis. Theoretically the stock clerk must recognize those cases by determining the status of operability of the end item affected, and he must also study the distribution of demands over a considerable period to detect a seasonal pattern. The latter is officially the responsibility of the commander but in practice he must delegate this responsibility because of the number of items that come up for possible deletion action each month. In fact the decision requires either research on each case or a sophistication in record keeping that is considerably greater than that now specified by the regulation.

Maintenance of the PLL thus consists mainly in the adjustment of the stockage quantity of the prescribed items selected for initial stockage, and the addition, deletion, or quantity adjustment of the augmentation items. There are additional changes as a result of variation in end-item density, the deletion of end items, and the introduction of new equipments not previously supported. New items may be accompanied by concurrent spares that must be retained for a period of 12 months, or they may merely require the introduction of the initial stockage for that item as selected from the prescribed items in the technical manual. These actions are relatively infrequent; the major maintenance effort is concentrated in the collection and analysis of the demand data.

REVISION OF DEPARTMENT OF THE ARMY POLICY

Additional comment is appropriate at this point on the recent DA policy change regarding the status of prescribed items that qualify for initial stockage. As indicated, DA policy in the past has specified mandatory stockage of such items. The revised edition of AR 735-35¹ published in October 1965 makes a break with this policy in that it permits major commanders to authorize the deletion from stockage of prescribed items that fail to qualify for stockage on the basis of the demand criteria for the augmentation component of the PLL. This option may be invoked only after the unit has been activated and operational for a period of at least 12 months. Except for this option the wording of the regulation is the same as before. The pertinent change is contained in the two passages quoted below. In both cases the initial-stockage items are the subject.

After the first 12 review periods, except for 'as required' items, the quantity will not be reduced below the initial authorized stockage level . . . unless otherwise directed by the major commander. The quantity for 'as required' items will be readjusted solely on the basis of demand experience. (6-6.b.(4))

And:

The initial authorized stockage level . . . represents the minimum allowance of repair parts to be stocked. However, except for 'as required' items, major commanders may authorize deletion of these items from the prescribed load list after the first 12 review periods if demand experience does not justify retention (3 demands in the most recent 180-day period). (6-6.d.(1))

The implications of this revision in DA policy are far-reaching, as is amply demonstrated by the experience of Seventh Army. In effect a decision on the part of the major commander to authorize deletion of the prescribed items from the PLL passes the responsibility for choice of stockage from DA level to the level of the unit commander. This is not necessarily a bad thing, but at the very least it can lead to considerable variation in the composition of the PLL among units having identical TOEs, for an authorization to delete prescribed items does not constitute a directive to delete all those items that do not qualify on the basis of demand experience. Presumably the unit commander may adopt any course he chooses, ranging from retention of all initial-stockage items to a policy of strict reliance on demand experience for the selection of repair-parts stockage. Based on estimates discussed in Chap. 5, this may result in a difference in the size of the PLL among like units on the order of 500 line items. Presumably there will be a corresponding difference in the combat readiness and peacetime demand accommodation of PLLs that differ by this amount.

Seventh Army units have in fact been operating for a considerable period under a policy that is even more permissive than the one allowed by the new regulation, and the result has been an astonishing variability in PLL size and composition, as shown in the next chapter. It is precisely this experience, with its implications for readiness, that has caused the G4 of Seventh Army to call for a general review of the PLL policy.

From the standpoint of management of repair parts stockage at higher headquarters, the mandatory stockage of the prescribed items at the unit has the effect of introducing a degree of uniformity in PLL composition and size that permits the comparison of the stockage of all like units within a command for the purpose of monitoring unit performance. Depending on the TOE, the initial stockage items may constitute a common base of stockage ranging from about 500 to 1000 items. There is little hope of achieving uniformity in detail in the augmentation component of stockage, since this component reflects the peculiarities of maintenance practices, age distribution of equipment, and the natural variation in demand. What should be relatively uniform is the net size of the PLLs of common TOE units. Under a given set of stockage criteria, a reasonably uniform number of items will qualify as augmentation stockage, and this quantity will stabilize at a steady-state value so long as there are no major perturbations in the equipment supported by the unit or in the level of peacetime training and other equipment usage. The combination of the peacetime augmentation with the prescribed-item stockage, a portion of which also meets the augmentation-stockage criteria, constitutes a total list that should be quite stable with regard to size. The simple comparison of total PLL size for like units can be a useful tool in monitoring the performance of the supply section of subordinate units. Aside from facilitating management, there remains a question of more fundamental importance with regard to the desirability of permitting optional stockage of the prescribed items. This is the question of whether adequate combat readiness can be achieved solely through the medium of demand-supported stockage and whether this stockage best serves the anticipated needs of the unit under peacetime and combat conditions.

Chapter 2

CURRENT PRESCRIBED LOAD LIST CHARACTERISTICS

The Seventh Army G4 Section has collected data on the stockage composition and status of nearly 80 units from its two corps and made these data available to the RAC Field Office for additional analysis. When appropriately assembled and analyzed, they illustrate the consequences of applying the combined United States Army, Europe (USAREUR) and Seventh Army policies with respect to unit PLL stockage. Extreme variation in local policy and in the PLL size and composition is evident, despite the fact that units apply stockage policy that is generally consistent with the provisions of the basic directives of the higher headquarters. This situation, along with the difficulty that units are experiencing in meeting assigned readiness objectives, had indicated the necessity for a review of Seventh Army policies.

STOCKAGE PATTERNS AT CORPS LEVEL

A comparison of the unit stockage situation in V Corps and VII Corps is given in Table 1 in terms of unit lines of stockage. The number of unit lines of stockage is not the same as the number of different stock numbers appearing in the consolidation of the PLLs of these units. The number of unit lines exceeds the number of FSNs because units have varying degrees of commonality of stockage. The total lines of stockage are broken out in the four categories of stockage discussed in Chap. 1. Status is available for two dates for V Corps units and for a single date in VII Corps units.

As the table shows, the total unit lines of stockage in V Corps units considerably exceed those in VII Corps, even though there are three additional units reporting in the latter. This reflects a basic difference in the application of stockage policy between the two corps that will be identified in greater detail. There is also a significant change in the total lines of stockage in V Corps in a period of just 30 days and a corresponding change in the percentage of zero balances. The explanation for these changes probably lies in the reporting data for the unit-readiness report. This report, designed to indicate the REDCON of units, includes in its Logistics Section an indicator for the status of the PLL in terms of the number of items at zero balance. The REDCON Report is prepared quarterly, so that the 30 September data reflect the status

of the PLL included in the report for that date. Although the reason for the change in status in the V Corps cannot be ascertained with certainty, knowledge of practices among the various units suggests that issue and addition to stockage probably were deferred until October, possibly with the intent of improving the readiness rating. The result, in any case, is a jump in lines of stockage and the considerable increase in the percentage of items at zero balance.

TABLE 1
Overall Comparison of V and VII Corps Unit Stockage

Stockage	V Corps		VII Corps
	30 Sep 65 ^a	31 Oct 65 ^a	30 Sep 65 ^b
Total unit stockage lines	21,854	23,087	15,897
Percentage at zero balance	18	23.6	25.0
Combat-essential lines	10,051	10,376	3,870
Percentage of total lines	46	45	24
Percentage of category at zero balance	14	18	31
Percentage of total zero balance	37	35	30
Demand-supported lines	5,604	6,468	7,570
Percentage of total lines	26	28	48
Percentage of category at zero balance	27.5	38	28
Percentage of total zero balance	40	45	54
Mission-essential lines	4,532	4,515	2,543
Percentage of total lines	21	19.5	16
Percentage of category at zero balance	13	17	19
Percentage of total zero balance	15	14	12
Concurrent-spare lines	1,637	1,728	1,910
Percentage of total lines	7	7.5	12
Percentage of category at zero balance	17.5	12	8
Percentage of total zero balance	7	5	4
Percentage of units having > 20% zero balance	21	51	52
Number of units with > 20% zero balance	8	19	21

^a37 units reporting.

^b40 units reporting.

The major difference in the total lines of stockage in the two corps is in the combat-essential and mission-essential categories. Thirty-seven V Corps units stock more than 2½ times the number of combat-essential items that are stocked in 40 units of the VII Corps (10,376 compared with 3870). The ratio of mission-essential stockage is almost two (4515 compared with 2543). These differences are probably accounted for in the same way as the change in total lines of stockage in the V Corps in the 30-day period, viz, a desire to achieve a satisfactory REDCON rating in the PLL section. Provision of a broad base of stockage, particularly if it included items not heavily demanded, would assist in effecting such an improvement. The ramifications of such a practice are discussed in

greater detail in Chap. 7. VII Corps policy appears to be to rely primarily on demand data for the selection of stockage. The number of demand-supported lines of stockage in VII Corps exceeds that in V Corps but not by a very significant amount. There are also comparable numbers of lines in the concurrent-spares category.

Table 1 also shows percentage of (a) the total lines in each category, (b) the lines in that category that were in zero balance on the date indicated, and (c) the total zero balances contributed by that category. In both corps the major contribution to the total number of lines at zero balance—about half—comes from the demand-supported lines. This is to be expected because peacetime activity is normally concentrated in this category. Slow response of the supply system and a general shortage of repair parts combine to hold the percentage of zero balances at a high level.

A more significant contrast of the stockage policies at corps level is obtained from a comparison of a group of like units from each corps, the results of which are shown in Table 2. The major difference in the number of unit lines of stockage in the combat- and mission-essential categories is again clearly evident. The significant change in the number of V Corps units with over 20 percent zero balances in only 30 days at least suggests the possibility of manipulation for reporting purposes. Current regulations with respect to REDCON reporting and rating certainly provide incentive for such manipulation, as is shown in another section. Overall, however, it is seen that the divergent stockage policies represented result in roughly comparable percentages of unit lines of stock at zero balance.

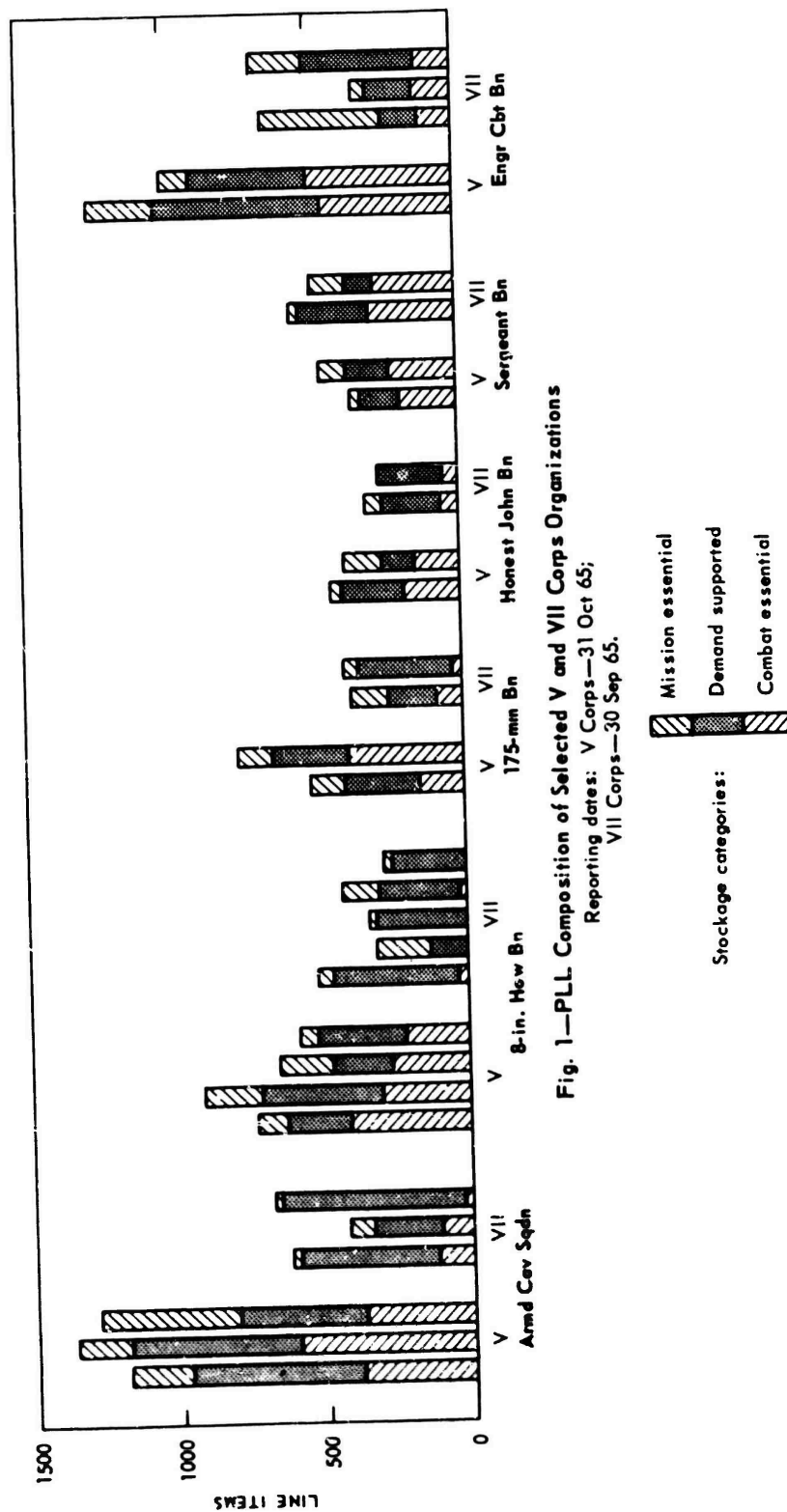
TABLE 2
Comparison of PLL Stockage in 15 Like-TOE Units in V and VII Corps

Corps	Date	Total unit lines	Lines at zero balance	Stockage category ^a				Units with > 20% zero balance
				D	E	M	P	
V	30 Sep 65	12,196	2219 (18%)	4111	5177	2011	897	2
V	31 Oct 65	12,909	3225 (25%)	4742	5083	2187	897	9
VII	30 Sep 65	7,615	2193 (29%)	4368	1526	810	911	9

^aD—demand supported; E—combat essential; M—mission essential; P—concurrent repair parts.

PREScribed LOAD LIMIT SIZE AND COMPOSITION

A detailed comparison of the size and composition of PLLs for the fifteen units represented in Table 2 is given in Fig. 1, with each type unit grouped by corps. Concurrent repair parts have not been included because of their very small contribution to the total PLL of any one unit. The general variation in PLL size in the two corps is evident again, as is the variation in composition. The average size of the PLLs in the armored cavalry regiments, for example, is 550 lines in VII Corps as compared with 1250 in V Corps. Comparisons of



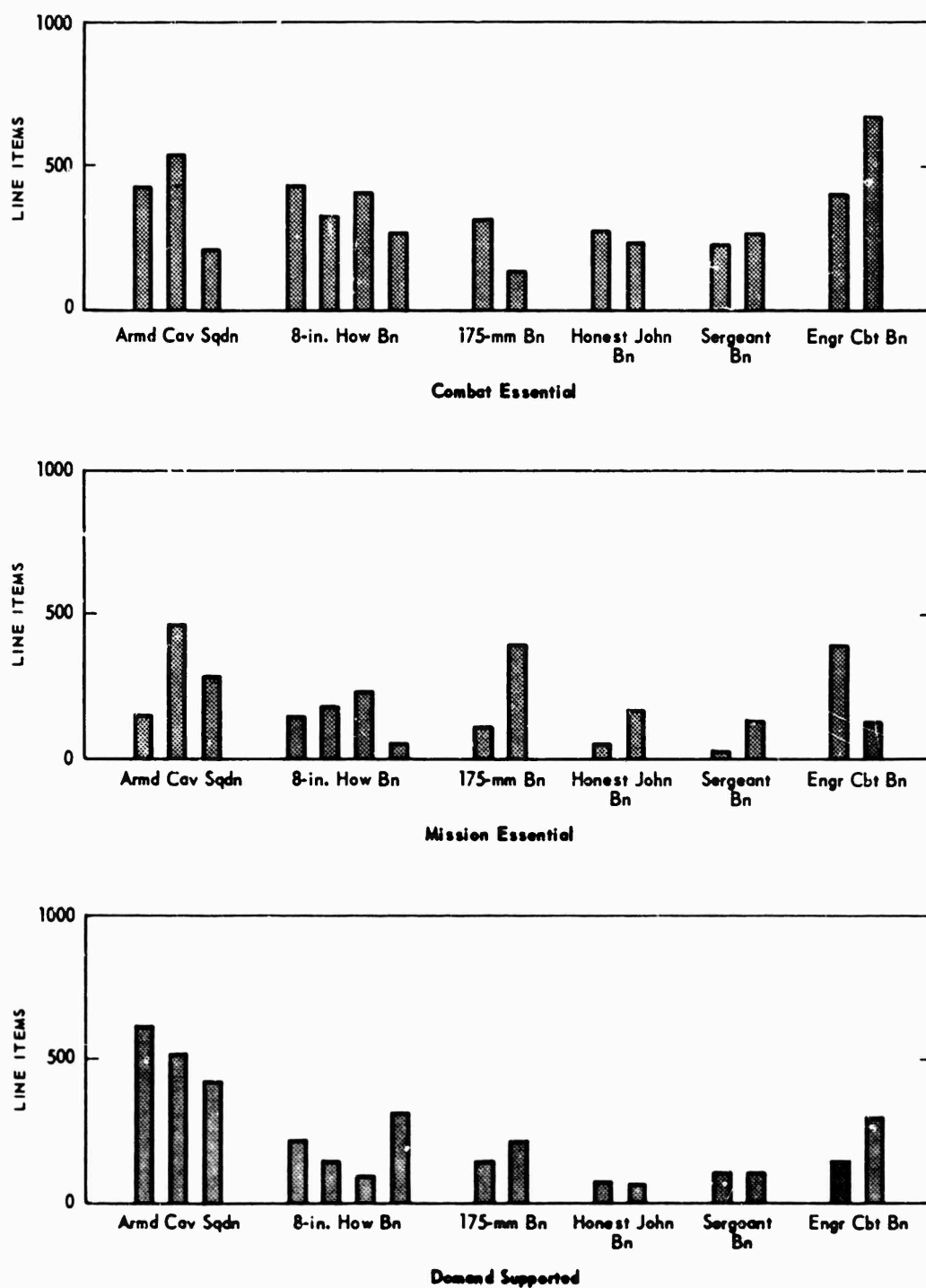


Fig. 2—PLL Components for Selected V Corps Organizations
Reporting date: 31 Aug 65.

the composition of the PLL reveal that in the 8-in. howitzer battalions, for example, the demand-supported component of the PLL in the V Corps comprises 38 percent, whereas in the VII Corps this component averages 79 percent of the list. Most significant, however, is the variation in PLL composition among like units in the same corps. In the 8-in. howitzer battalions in VII Corps, for example, the demand-supported components range from 56 percent to 95 percent. Figure 2, in which the various components of the PLL are plotted side by side, brings out even more clearly the variation in composition among like units. The units depicted are all from the V Corps and presumably are operating under the same general policy with regard to the stockage of combat- and mission-essential parts. Large variations in all categories are evident among like TOE units, indicating that even within corps policy constraints each unit is essentially following a policy all its own. The results suggest a chaotic situation.

DEMAND RECORDING

A widespread difficulty in the full and accurate recording of demands is experienced by Seventh Army units. In the course of making courtesy inspections during the latter part of 1965, the Seventh Army Command Supply Maintenance Inspection Team (CSMI Team) collected data on the percentage of demands that are actually recorded on the stock record card in the PLL or fringe file as appropriate. In each unit a sample of 100 demands was selected at random from the transaction register and was checked for posting to the record of demands in the appropriate PLL or fringe file. In a total of 25 units that were rated unsatisfactory in record keeping, the overall percentage of demands recorded was a meager 55 percent. Individual performance ranged from a low of 7 percent to a high of only 80 percent. Similar results were reported by the Seventh Army communications zone (COMMZ) Supply Assistance Team, which examined the supply situation in one Seventh Army division early in 1965. In a total of 29 divisional units that maintained PLLs, the average percentage of demands recorded was about 50 (unpublished data furnished by Seventh Army G4). Under the pressure of daily operation, it is apparently very difficult to achieve anything like the full recording of demand data at the unit level. This situation leads to an apparent reduction in the demand rate of the active items and has a significant effect on the size and adequacy of the demand-supported component of the PLL as well as on the stockage quantity for prescribed items. These implications are examined in more detail in another section.

SUMMARY

The results of the preliminary investigation revealed gross variation in the stockage of like units and in the relative size of the various components of PLLs and widespread failure to record demands. It is natural to presume that these are directly related to the failure of units to meet assigned readiness criteria with respect to parts stockage and equipment availability. These combine to indicate the necessity for a general review of policies governing unit stockage.

Variation in the composition of parts stockage and in the relative size of components of the PLL are obviously not in themselves bad except insofar as they imply real deficiencies in terms of demand accommodation, lack of commonality, and, perhaps most important, lack of true combat readiness.

It need hardly be emphasized that the chief concern is the selection of a policy that will lead to improvement in unit readiness for combat. This implies not only the operational readiness of equipment at the outbreak of hostilities but the ability to maintain such a condition in the early stages of combat, when normal supply support may be curtailed. Detailed data on the readiness condition of units in the PLL are not given here because they would require an unnecessarily high classification of this document. It is apparent that all the units for which data have been presented cannot be in comparable states of readiness with regard to repair-parts stockage. The variation in both size and composition makes the assumption of equal readiness untenable. Uniformity of stockage among like units is not sought as an end in itself; what is sought rather is a uniformly high state of readiness. The present policy admits of the widest of interpretations, and it appears that a more narrowly defined set of rules would achieve a higher level of readiness among all units and would, incidentally, also produce a corresponding higher degree of uniformity in the stockage of like units. This result would facilitate the management of supply at unit level since it would make possible the monitoring of unit supply performance from a relatively few elements of data on the size and composition of unit PLLs.

Chapter 3

DEMAND CHARACTERISTICS

Basic to the consideration of any repair parts stockage policy is an appreciation of the nature of the demands placed on the supply section of the unit maintenance activity. In this chapter the demand experience of 13 battalions organic to the infantry division are examined to observe the (a) characteristics of demand in terms of the numbers of active stock numbers involved, (b) number and frequency of demands, (c) commonality of usage among units, (d) quality of the stock list as reflected by the extent to which the authorized list accommodates demand, (e) demand satisfaction as reflected in the extent to which demands are filled, and (f) implications of increasing demand accommodation. A demand as used here is defined as a "request for a specific stock number independent of the quantity needed." Some data are presented at the end of this chapter that treat the distribution of quantity required given a demand.

SOURCE OF DATA

Through the cooperation of the 3d Inf Div (Mech), and as a result of that unit's forward-looking data-collection program, detailed demand data were made available for virtually all units within that division. Most of these data were processed and converted to manageable form through the assistance of the Computer Sciences Center at RAC/McLean. The data employed in this study cover the period from May to October 1965 and include the experience of seven mechanized infantry battalions, three artillery battalions, and three armored battalions.

A word should be said about the program that generated the data. Since May 1965 the 3d Div has had a program of central PLL management for selected units. To inaugurate this it was necessary to collect the complete demand experience of the affected units. This was done by having each unit prepare its transaction register in duplicate and submit it to division headquarters. These records were kept with greater than normal care and were more complete than called for in the regulation. Because each request that is submitted by the supply section must be entered in the transaction register to be assigned a request number, and because each demand made on the supply

section triggers a corresponding request for stockage from the supporting DSSA, these records are considered greatly superior to most others that are available even though they are not completely accurate. The transaction register data were then keypunched for subsequent machine processing. RAC assisted in this process and made the resulting card decks available to the division in support of its program. It has been found that the document register contains a much more complete record of the demands for repair parts within a unit than the record-of-demands cards of the visible PLL file and the fringe file. Use of the transaction register is essential in the preparation of a request, whereas it is possible to overlook the recording of the demand in the other records, and this occurs with alarming frequency in many units.

SUMMARY OF THE DEMAND DATA

Repair parts demand data for the three types of battalions are summarized in Table 3. It is seen that among the infantry battalions there is a reasonable uniformity in the number of active stock numbers and demands. The

TABLE 3
Demand Data Summary for Three Types of Battalions
(May-October 1965)

Category	Mechanized infantry battalions							Consolidation of units
	1/4	2/7	1/7	1/15	2/15	1/30	2/30	
Number of federal stock numbers	2,941	3,477	2,835	2,762	1,727	2,234	3,048	10,501
Number of demands	6,295	7,637	5,771	5,779	2,904	4,488	6,355	39,009
Total quantity	35,703	42,068	19,730	25,976	13,576	15,663	51,380	204,096

Category	Armored battalions			Consolidation of units	Artillery battalions			Consolidation of units
	1/64	2/64	3/64		1/10	2/39	2/41	
Number of federal stock numbers	1,849	2,588	3,028	5,535	2,584	2,409	2,694	5,746
Number of demands	3,279	4,782	6,940	15,001	5,449	4,961	4,941	17,098
Total quantity	19,164	36,668	79,831	135,663	27,646	41,613	43,186	112,445

numbers for the 2/15 Battalion are an exception, but it is not clear whether this is attributable to a genuine difference in requirements or to incomplete record keeping. Consolidation of the data indicates, however, that little commonality in usage occurs. Although over 10,000 different stock numbers were active in the units, individual units experienced demands for an average of only about 3000 of these during the test interval. If one considers the consolidated data for the seven battalions over a 6-month period as being equivalent to 42 months of experience in an average battalion, 6 months is a relatively short period of observation for a single battalion with regard to the variety of demand that will ultimately be experienced.

The armored units exhibit considerable variation across the board and the artillery units are remarkably uniform with regard to active stock numbers and numbers of demands. Considered as a group, all 13 units exhibit roughly the same level of traffic, which lends support to the assumption that the experience of the infantry battalions is typical. This is partly because these units all have a large number of the same types of vehicles and small weapons. In general during a 6-month period the average unit will experience approximately 6000 demands distributed over some 3000 different stock numbers. This gives some indication of the difficulties associated with the selection of stockage at the unit level.

COMMONALITY OF REPAIR-PARTS USAGE

As already indicated, one of the most striking features of the repair parts traffic in a group of like units is the profusion of different stock numbers demanded and the very low commonality of usage among the individual units in the group. Figure 3 shows the commonality of item usage among the seven mechanized infantry battalions during the 6-month period. Almost 70 percent of the items that were active during the test period had usage in only a single battalion; less than 3 percent had usage in all seven. The same general pattern is repeated in Fig. 4, where attention is restricted to the commonality of items that were demanded three or more times and thus qualify as demand-supported items. Almost 1700 different items qualified for stockage in one or more battalions during the period but less than 4 percent qualified in all seven.

This pattern changes radically if, instead of considering only items that have three or more demands in each case, the usage of those items that qualify for stockage in at least one battalion is considered, and the overall commonality of usage (one or more demands) of this class in the entire group of units is examined. Figure 5 plots the analog of Fig. 3 for this restricted class of items. Now the distribution is almost uniform. The largest proportion of the items finds usage in four units, although six and seven units have virtually the same proportion. This is the class of items from which the augmentation stockage will be selected through application of the stockage criteria. The stockage process is modeled in App B, and the results are applied in Chap. 5 to compare the PLL size, demand accommodation, and turnover rate under different stockage policies.

Figures 6 and 7 show the commonality plots, in necessarily abbreviated form, for three artillery and three armored battalions. The pattern is similar to that of Fig. 3.

DEMAND ACCOMMODATION

A distinction is made between demand accommodation and demand satisfaction. The former is a measure of the quality of a stock list, and the latter is a measure of the performance of a supply activity. Demand accommodation is expressed as the percentage of all demands that are for items appearing in the authorized stockage list. As such it represents an upper bound to demand

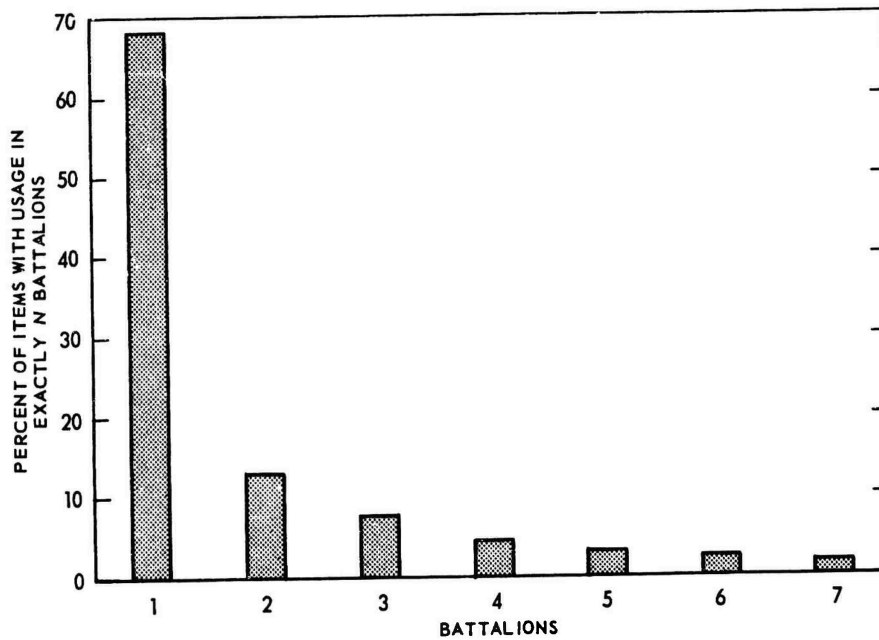


Fig. 3—Usage Commonality of Items Active in One or More Battalions
 Type of battalion: mechanized infantry; period: May-Oct 65;
 active items: 10,501; N: no. of battalions.

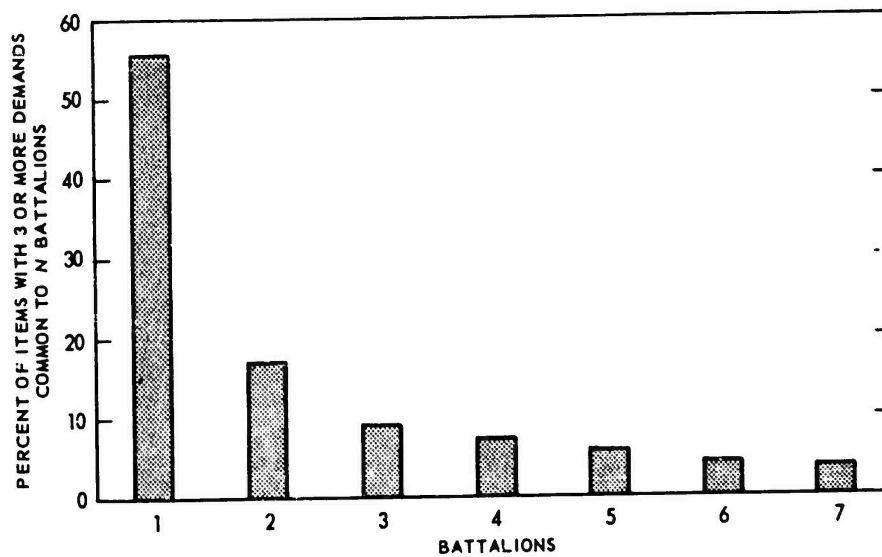


Fig. 4—Commonality of Items Having Three or More Demands in One or More Battalions
 Type of battalion: mechanized infantry; period: May-Oct 65;
 qualifying items: 1685; N: no. of battalions.

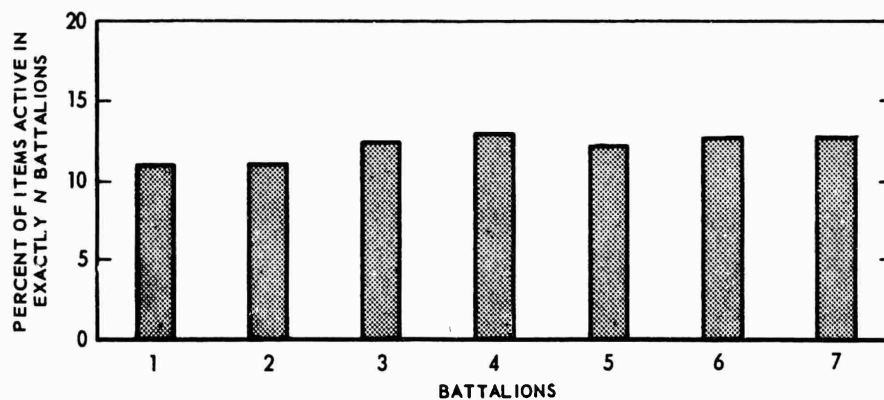


Fig. 5—Usage Commonality among Items Qualifying for Stockage in at Least One Battalion

Type of battalion: mechanized infantry; period: May-Oct 65;
qualifying items: 1685; N: no. of battalions.

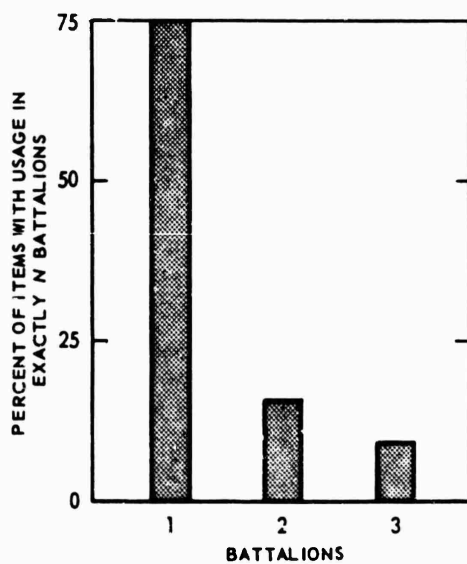


Fig. 6—Usage Commonality of Active Items in Armored Battalions

Type of battalion: armored; period: May-Oct 65;
active items: 5535;
N: no. of battalions.

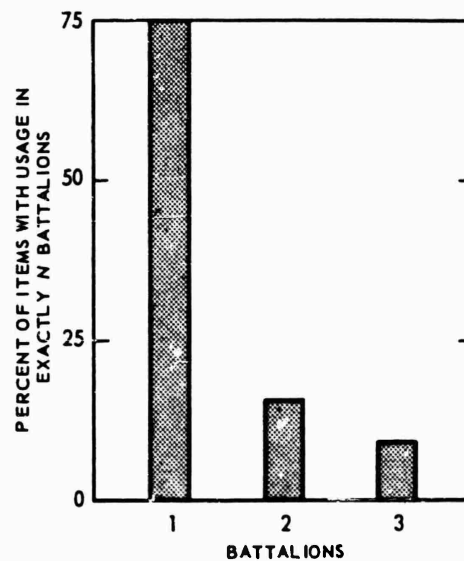


Fig. 7—Usage Commonality of Active Items in Division Artillery Battalions

Type of battalion: division artillery;
period: May-Oct 65; active items: 5746;
N: no. of battalions.

satisfaction (percentage of demands given immediate and complete fill). Unless unauthorized stock is on hand, demand satisfaction can be no greater than the accommodation afforded by the PLL. When repair parts are in full supply, PLL accommodation limits demand satisfaction. When parts are in short supply, as is currently the case within Seventh Army, these shortages govern demand satisfaction. Under these conditions the poor quality of the PLL as a list tends to be overlooked because demand accommodation is no longer the limiting factor in unit supply performance. The importance of the list should not be minimized, however, since it represents the ultimate limit on supply performance by the unit supply activity.

The objective of a commercial stockage list is to provide an acceptable demand accommodation with as few line items as possible. The situation with regard to the PLL is somewhat different in that it has the objective of preparing the unit for two possibly radically different sets of conditions—normal peacetime maintenance activity and combat. The peacetime efficiency of the list may well be compromised by the requirement for combat, since peacetime use of the end items supported may not match the use to which it will be subjected in combat. With regard to the augmentation component of the PLL, however, the normal stockage objectives apply. Depending on the approach taken to the problem of transporting the unit stocks, the deciding factor as to the number of lines of stockage may be either a predetermined level of demand accommodation or an arbitrary limitation imposed by the limited capacity of the unit to transport stocks. A further limitation is that it is not economical to provide demand accommodation beyond the point at which the increment in stockage exceeds the corresponding increment in demand accommodation. In view of the variety of stockage items required to satisfy all demands, the achievement of anything approaching 100 percent demand accommodation is clearly out of the question. The extent to which it is profitable to increase stockage items as a percentage of total requirements is dependent on the supply echelon in question. It appears from the data that the percentage of total demands that can be met by a given fraction of the total stockage required is smaller at the lower echelons of supply than at the higher. A given percentage of the list will accommodate a smaller percentage of total demands at the DSSA, for example, than at the Seventh Army ICC. At the higher levels the base of active items broadens at a greater rate than the distribution of demands. There is also a concentration of the density of end items of the same type so that a smaller proportion of the total active stock numbers accommodates the same proportion of demands.

Since 6 months is a relatively short period of observation for any one unit, it is the practice throughout this analysis to consolidate the data from the seven battalions and treat them as if they represented a much longer history for a single typical unit. The basic assumption is that the processes generating demands and the equipment and the environment are virtually identical in each of the units. This assumption is not strictly true, but valid (although rough) estimates of the demand characteristics within a battalion can be obtained in this fashion. It is reasonable to assume that better answers can be obtained in this fashion than by considering only the history of individual units for a short period, and checks have indicated that this assumption is justified (see App B).

Demand accommodation data are plotted in Fig. 8 for available levels of consolidated demand experience in the seven test battalions, each curve representing a different number of battalion-months of experience and consequently a different stockage base. As shown by the variation in the curves, the percentage of total stockage required to accommodate a given percentage of the

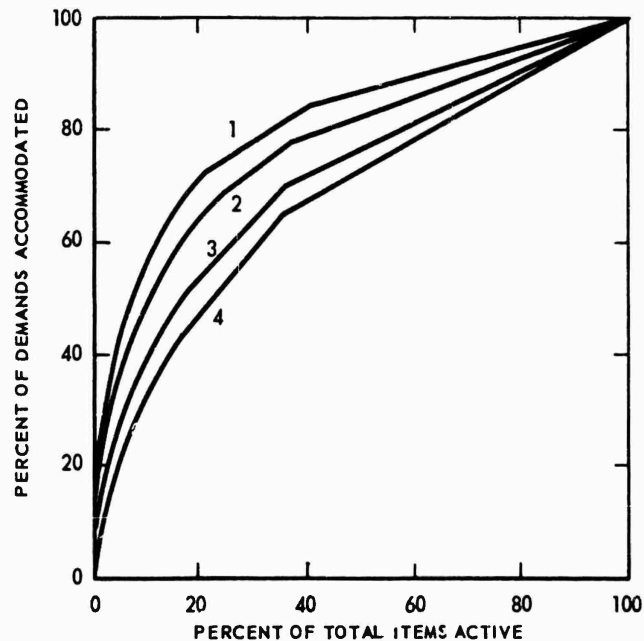


Fig. 8—Demand Accommodation for Varying Battalion-Months of Experience

Curve	Battalion-months	Demands	Active items
1	42	39,009	10,501
2	21	19,887	7,087
3	6	6,295	2,952
4	3	4,182	2,306

demands diminishes as the base of stock numbers becomes larger. As an example, accommodation of 60 percent of all demands can be accomplished with approximately 12 percent of the total list in the case of the largest base of stock numbers (42 battalion-months), whereas accommodation of the same percentage of all demands with the smallest base (3 battalion-months) requires about 32 percent of the total list.

Some stability is evident, however, in the actual number of items required to produce specified demand accommodation levels of less than 100 percent. The progression in the actual numbers of items required to produce selected levels of demand accommodation is plotted in Fig. 9 for different numbers of battalion-months of experience. The progression in the size of the base of line

items to achieve 100 percent accommodation is also plotted in the same figure. The size of this base has not achieved stability at the upper limit of the 42 battalion-months of data available. At the 60 percent and 40 percent accommodation levels there is virtually no change in the number of items after 21 battalion-months.

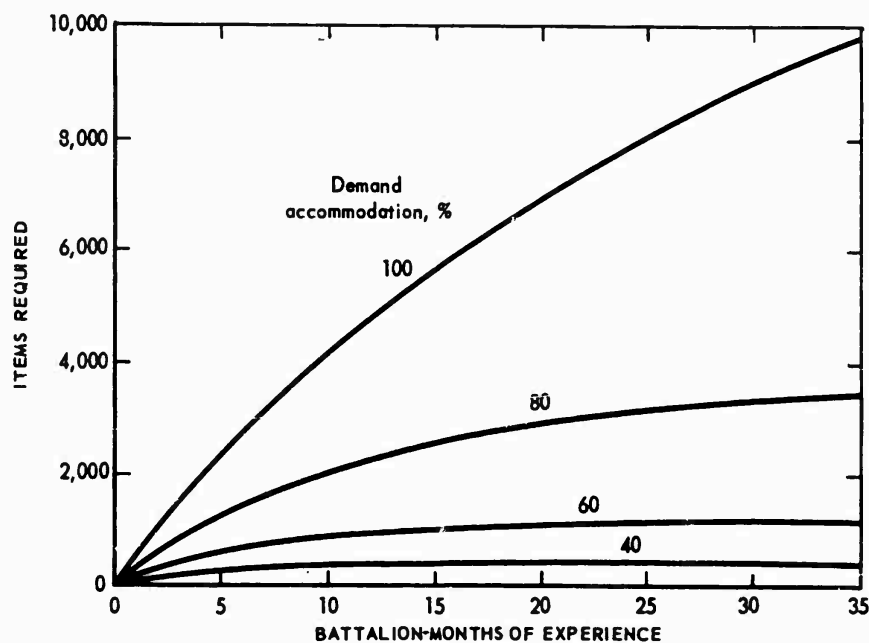


Fig. 9—Items Required for Various Levels of Demand Accommodation as a Function of Battalion-Months of Experience

From Fig. 8 it is seen that demand accommodations in excess of about 70 percent are very costly in terms of the additional stockage increment required. Below this limit, however, as is shown in Fig. 9, the number of different line items is stable for a given accommodation. This fact makes it possible to plot the number of line items required to achieve a given level of demand accommodation, as shown in Fig. 10.

The data plotted here are, of course, after the fact and represent the maximum performance that could have been achieved in the accommodation of demands from a given number of lines of stockage. They provide a valuable base line for the measurement of the performance of a given PLL in effect over the period in question or for a proposed set of stockage criteria, provided that the expected number of demands accommodated can be determined. Both of these types of analysis have been carried out and are discussed later. Under current regulations the mechanism for identifying those lines that will approach the performance indicated here is to count demands made against each stock number and add them to the PLL as they meet certain frequency requirements and to delete them if the apparent frequency falls too low. The purpose of this

process is to produce an efficient set of items that will produce something close to the maximum demand accommodation possible from the resulting number of stockage lines.

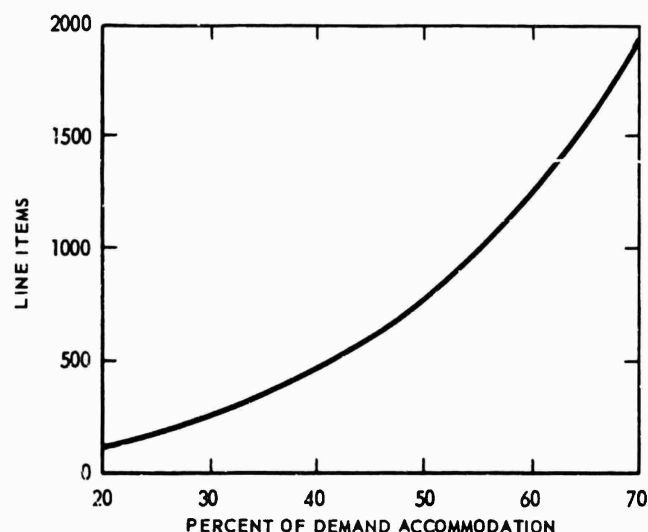


Fig. 10—Number of Line Items Required To Produce a Given Demand Accommodation

The set of lines producing maximum demand accommodation may itself have a great deal of predictive value since it is reasonable to assume that the lines that worked best in one 6-month period will continue to produce well in the next month. If the list is updated every month on the basis of the most recent 6 months of history, an alternative process is available for the selection of appropriate stockage items. This process is more direct than that of counting demands by individual stock number and may provide superior prediction of future demand experience. This issue has not been resolved to date, but will constitute a part of the effort in a follow-up study.

DISTRIBUTION OF DEMAND RATE

With the raw data shown in Table 4 it is possible to indicate roughly the distribution of demand frequency among the active line items applying to a mechanized infantry battalion. If the number of lines exhibiting a given demand frequency are accepted as representative of the proportion of lines having a demand rate centering on the observed frequency, these data can be employed in a model of the stockage process to determine certain characteristics of the PLL as a function of the criteria for item selection. Figure 11 shows the distribution of demand frequency derived from 42 battalion-months of data from the mechanized infantry battalions. The basis for the percentage values is the total number of items active in the period. The observed frequencies have

TABLE 4
Consolidated Demand Data for Seven Mechanized Infantry
Battalions of the 3d Infantry Division
(May-Oct 1965)

Stock numbers	Times demanded	Demands accommodated (cumulative)	Stock numbers (cumulative)	Percent of demands accommodated (cumulative)	Percent of total active stock numbers (cumulative)
		10,495	214	26.9	2.0
14	27	10,873	228	27.7	2.2
9	26	11,107	237	28.5	2.3
20	25	11,607	257	29.7	2.5
15	24	11,967	272	30.7	2.6
19	23	12,404	291	31.7	2.8
19	22	12,822	310	32.9	3.0
26	21	13,368	336	34.2	3.2
24	20	13,848	360	35.5	3.4
19	19	14,209	379	36.4	3.6
37	18	14,875	416	38.0	4.0
23	17	15,266	439	39.0	4.2
36	16	15,842	475	40.5	4.5
37	15	16,397	512	41.8	4.9
50	14	17,097	562	43.9	5.4
67	13	17,968	629	46.0	6.0
70	12	18,808	699	48.0	6.7
67	11	19,545	766	50.0	7.3
74	10	20,285	840	52.0	8.0
100	9	21,185	940	54.5	8.9
141	8	22,313	1,081	57.0	10.3
176	7	23,545	1,257	60.0	12.0
224	6	24,889	1,481	63.8	14.1
283	5	26,304	1,764	67.5	16.8
424	4	28,000	2,188	72.0	20.8
662	3	29,986	2,850	76.5	27.2
1372	2	32,730	4,222	84.0	40.2
6279	1	39,009	10,501	100	100

been adjusted to the equivalent single-battalion rate expressed in terms of demands per 180 days. The base for demand rate has been selected as a matter of convenience, since a 180-day period is the base for current stockage and deletion criteria.

The data plotted in Fig. 12 are of greater interest and utility. The actual number of line items has been used as the dependent variable and the results for 21 battalion-months of experience have been plotted together with the experience of 42 battalion-months from the seven battalions. A comparison of the two curves shows that, except for low apparent-demand rates, there is a stable quantity of line items having demand frequencies greater than about 0.5 demands per 180 days. The proximity of the curves for 21 and 42 battalion-months of data indicates that the distribution based on the greater period is quite close to the steady-state distribution and may be used for computational purposes. It is shown in Chap. 5 that repair parts having demand rates less than 0.5 demands per 180 days have a very low probability of qualifying for stockage and thus

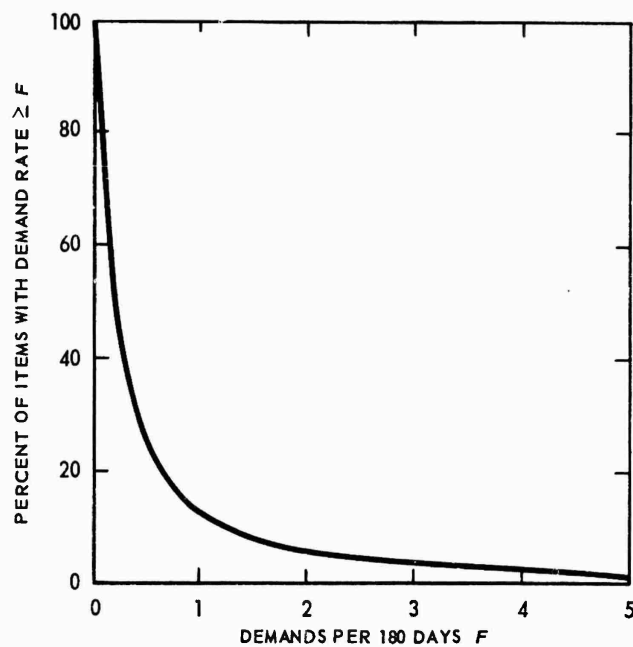


Fig. 11—Percentage of Items with Apparent Demand Rate $\geq F$

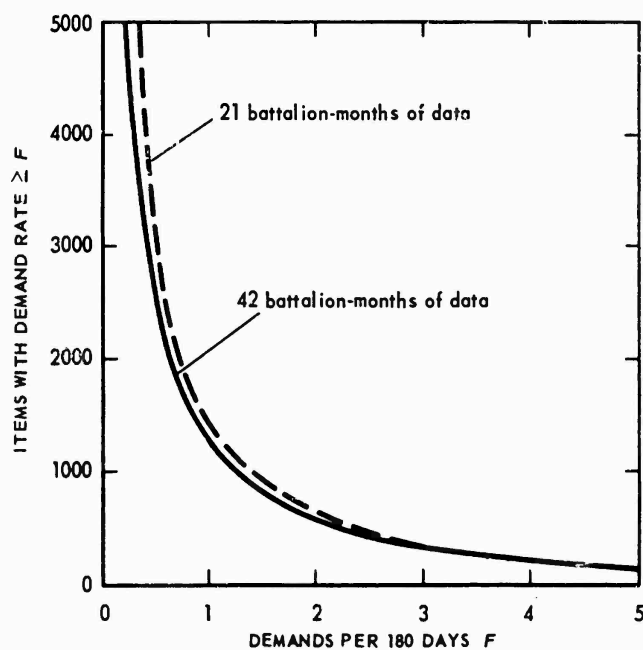


Fig. 12—Number of Different Items with Equivalent Battalion Demand Rate $\geq F$

do not contribute to the demand-supported component of the PLL. The stability observed here is but another aspect of the quantitative stability pointed out earlier in the discussion of demand accommodation. The distribution of the demand rate derived here is employed in the next chapter as an input to a model of the stockage process to compare the expected size, demand accommodation, and turnover rate resulting from the application of alternative stockage policies.

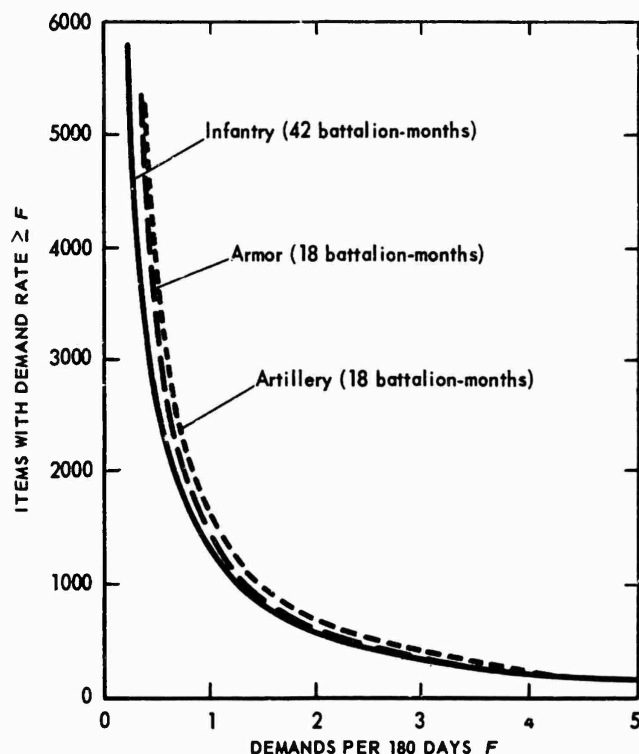


Fig. 13—Demand Rate Distribution among Active Lines in Three Types of Units

Figure 13 shows the distribution of demand frequency based on 18 battalion-months of data for armored and artillery battalions superimposed on the plot of the near steady-state frequency distribution for the infantry battalions. The remarkable similarity of these curves and the similarities in demand characteristics observed earlier indicate that the subsequent derivations of infantry-battalion PLL characteristics will be representative of other types of units as well.

DEMAND QUANTITY DISTRIBUTIONS

Stockage at unit level is of a very elementary kind. There is no safety level and no allowance for replenishment time so that the stockage quantity is

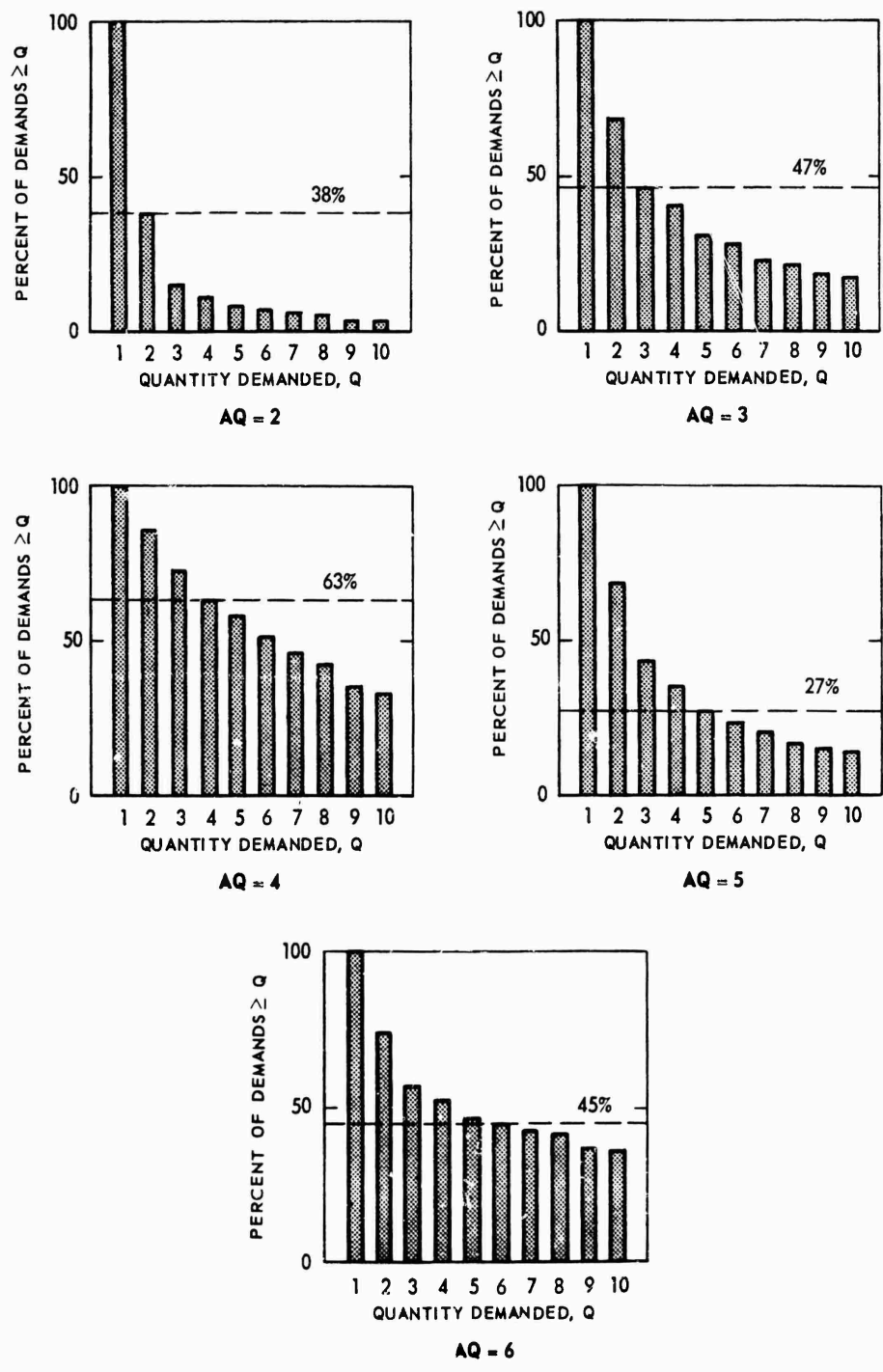


Fig. 14—Demand Quantity Distributions for Selected AQ Groups
 AQ, authorized stockage quantity; minimum AQ, 2.
 — — Percent demands for quantities $\geq AQ$

merely the nearest integer equivalent of the average quantity demanded in 15 days as determined from the demands over a period of 180 days. Relative to the operating level of 15 days, demands for the majority of items occur infrequently and at irregular intervals. Over 75 percent of the items stocked have an authorized stockage quantity of two so that it frequently happens that a single demand is for a quantity equal to or greater than the stockage quantity. Thus the line is driven to zero balance as the result of a single demand. With regard to the average number of zero balances in a PLL, an important factor is the proportion of demands that immediately exhaust the stockage.

Demand quantity distributions have been determined for demands against items grouped by the authorized stockage quantity. These are plotted in Fig. 14 for several authorized-quantity groups in the form of the percentage of demands equal to or exceeding the indicated quantities. It is assumed here that the minimum stockage quantity is two. This conforms to Seventh Army practice and to the intent of DA regulations as discussed in Chap. 5. In each group the percentage equal to or greater than the authorized quantity is indicated. Overall, some 9000 demands against 675 items were examined. Approximately 40 percent of the demands were for quantities equal to or exceeding the authorized stockage quantity.

Some demands for quantities equal to or greater than the authorized quantity will create a new zero balance; some will not because they will encounter an existing zero created by an earlier demand. Other demands for less than the authorized quantity may, however, cause a zero balance by exhausting stockage reduced by a previous demand. In another section of this study these data together with the demand traffic and replenishment times are used to provide a crude indication of the average number of zero balances that are to be expected in the PLL stockage as a function of the performance of the supporting supply echelons and the quality of the PLL.

Chapter 4

PREScribed ITEM CHARACTERISTICS

STATUS OF PRESCRIBED ITEMS

A central issue with regard to the composition of the PLL is the status to be accorded the prescribed items appearing in the initial stockage. Should these items be retained in the PLL independent of demand experience, as prescribed in the basic DA regulations, or should the major commander invoke the prerogative of converting these items to an optional stockage position in units having more than 12 months' experience? Unfortunately a complete answer to this question requires the opportunity to test the performance of the prescribed items in satisfying demands under combat conditions in the environment in which the unit expects to fight. These positive data are happily not currently available within Seventh Army. It is hoped that this type of data is being collected in Vietnam and will eventually be employed by the DA in the review and updating of the listings of prescribed items.

Even though direct evidence with regard to the efficacy of the prescribed items is not at hand, relevant data are available in the form of peacetime usage. Because many end items do receive peacetime usage that is comparable to combat usage, the complete absence of usage of such items would be convincing evidence that the listing of parts is faulty. On the other hand considerable peacetime usage would indicate that the listings are reasonably good and that stockage of such items would serve a useful peacetime function as well. Some peacetime usage data have been collected on combat-essential items in general and on the usage of the prescribed items for a mechanized infantry battalion in particular.

COMBAT-ESSENTIAL-ITEM USAGE

The data on prescribed-item usage available for this study were collected before the receipt of the new edition of AR 735-35 and relate only to items previously designated as combat-essential. These items now constitute the major portion of those currently designated as prescribed items. The remainder are high-mortality items—i.e., those that are not necessarily functional but are estimated to have a relatively high usage rate for a given end-item density. Hence it may reasonably be assumed that the overall usage of prescribed items is not less than is indicated by the use of combat-essential items.

In the course of the study fragmentary data on the usage of combat-essential items that became available indicated that the peacetime usage of these items was considerably greater than was commonly suspected; they are summarized in Table 5. Except for the engineer items, about two-thirds or more of the various items listed in this table show stockage at the Seventh Army depot level, which provides a lower bound on the overall usage of these items. Presence on the depot stockage list requires the occurrence of at least 12 demands in the previous year. The actual percentage of items used at least once in the year preceding the indicated date is very probably considerably higher. The engineer combat-essential items are for the variety of makes and models of engineer end items supported by one or more of the seven mechanized infantry battalions for which data are available.

TABLE 5
Combat-Essential Item Usage

Number of items	Category or end item	Percent usage (TAERS) Oct 63-Sep 64	Percent ^a Seventh Army stockage Jul 65
800	Ordnance tank-automotive	—	68
400	Ordnance weapons command	—	67
546	Miscellaneous infantry battalion (mech)	—	65 ^b
191	M60	28	71
70	M113	63	89
34	M151	97	80
34	M37B1	91	85
79	M35	60	81
167	Engineer items (mech inf bn)	59 ^c	40

^aActual usage is no less than the value here since 12 demands in 360 days or less are required for Seventh Army depot stockage.

^bSeventy-nine percent of these items were stocked by COMMZ

^cUsage value is based on 21 battalion months of mechanized infantry battalion experience (May-Oct 65).

The usage data for the selected vehicular end items were obtained from listings of part replacements taken from TAERS data for Seventh Army fleets over the period from October 1963 to September 1964. These figures generally confirm the data based on Seventh Army depot stockage except for the M60 tank. This anomalous result in the case of the M60 indicates a radical change in the pattern of parts demand, a lack of accuracy in reporting on these end items, or a combination of the two. There are other cases that indicate the occurrence of one or both of these alternatives but to a lesser degree.

Since stockage of combat-essential repair parts was made optional, it was apparently considered by many within Seventh Army that the usage of combat-essential items was comparatively low and that the majority of these items constituted dead stockage of little value during peacetime and of dubious value during initial combat. The results shown in Table 5 indicated that a more

detailed investigation of the usage of such parts, at least for a selected type of combat unit, was needed. The mechanized infantry battalion was a natural choice in view of the data in hand and the high density of this TOE within Seventh Army.

MECHANIZED INFANTRY BATTALION PRESCRIBED-ITEM USAGE

To examine the peacetime utility of the initial stockage for a specific type of unit more closely, an effort was made to identify as many of these items as possible for a specific battalion. The list of equipment supported by a given battalion (1/15) was obtained, all available technical manuals were assembled, and a partial initial-stockage list was prepared. This was supplemented by listings of combat-essential repair parts made available by the Seventh Army G4. The result was a list of some 625 items. This list is incomplete but a knowledge of the end-item coverage that was available permits a reasonable estimate of the total number of items that would appear in the initial stockage of a typical mechanized infantry battalion. The results of this estimate, which includes only mission-essential end items, are shown in the accompanying tabulation.

Item	Number
Ordnance tank-automotive	360
Ordnance weapons command	280
Chemical and engineer	110
Total	750

The 625 items give virtually complete coverage of the combat-essential items, the major part of the difference being the estimated number of additional high-mortality items that are presumed listed in the manuals that were not available. This estimate is based on the proportions of combat-essential and high-mortality items observed in the manuals that were in hand. The initial-stockage repair parts included in this listing relate only to those reportable end items in the battalion that are defined by the DA in AR 711-2.⁴ This circular contains the official list of "move, shoot, and communicate" end items considered essential to the mission of the unit. These end items are those considered in preparing the Unit Readiness Report entry, "equipment on hand." Use of this list focuses attention on those equipments supported by the unit that are most important in the performance of the combat mission. This restriction eliminates about 100 items listed in the older technical manuals as combat-essential or high-mortality items. Presumably many of these items will be eliminated from the prescribed-item lists as the manuals come up for revision. For a mechanized infantry battalion, 94 line items are included in the category of reportable items out of a total of about 228. Exclusive of signal items, either combat-essential items lists or the technical manuals were available for 66 of the remaining 70 end items.

Note that the breakdown of technical service categories in the prescribed-item tabulation does not include any quartermaster or signal items. No

quartermaster end items in the TOE are considered reportable with the exception of two tool kits. It is assumed that these kits have no associated prescribed items. With regard to signal end items, manuals were available for 14 of 24 reportable equipments and none of these indicated any initial-stockage items for the end-item densities in the test battalion. In general only a very few repair parts are authorized for unit replacement and these appear to be restricted to items such as panel lamps. On the basis of the 60 percent coverage of applicable technical manuals it is assumed that the contribution of signal items to initial stockage of the test unit is either nil or very small. A possible exception may be the new VRC12 radio, since the concurrent spares for this item located at unit level comprised about 84 different items.

In summary the figure of 750 prescribed items represents a value that is considered to apply to the average mechanized-infantry TOE with a variation of less than 10 percent. There will always be minor variation in the specific number from unit to unit as a result of the variation in make and model of the equipment corresponding to the general TOE line-item numbers. This estimate is sufficiently close for the purposes of this study, but it would not be adequate for the initial-stockage list of the unit on which it was based. In the subsequent material the usage and demand-accommodation data are based on the sample of 625 prescribed items identified, which constitutes about 83 percent of the estimated total. Because most of the "missing" items fall in the category of high-mortality items, it seems reasonable to assume that the data reported here will be representative of the list as a whole.

The sample of 625 items prescribed for infantry battalion use and identified as initial-stockage items for a specific unit of the test group was checked against the consolidated demand experience of seven battalions of the same division for the period of May to October 1965. The results are shown in the accompanying tabulation.

Lines in sample	Active lines	Percent active	Demands accommodated	Demands per line
625	508	81	6,956	11.2

A significant result here beyond the relatively high percentage of use is the number of demands accommodated and the average number of demands per line item that occurred. Even though nearly 20 percent of the items accommodated no demands in the test period, the overall average of 11.2 demands/line is three times the average for all lines that were active during the same period, viz, 3.7 demands/line. If the performance of the estimated total of 750 prescribed items is assumed to be about the same as that indicated by the 83 percent sample, about 8400 demands would be accommodated by the total initial stockage, which is about 21 percent of the total number of demands that occurred in the test period.

The distribution of apparent demand frequency in the sample of prescribed items was determined and is plotted in Fig. 15. The contrast between this distribution and that for all active lines as shown in Fig. 11 is apparent. A much greater proportion of these lines have a relatively high peacetime-demand rate. These data are used in Chap. 5 to estimate the net PLL size that would result

from the stockage of the initial load plus the peacetime augmentation of demand-supported items.

The sample lines that showed no activity should be examined with a view toward revision of the listings. Some may be identified in the sample by superseded stock numbers and some may continue to be needed for combat, but

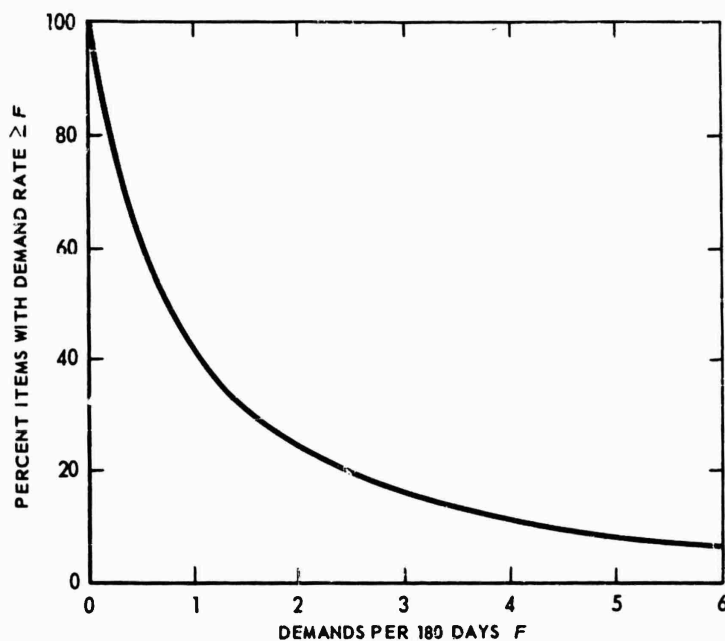


Fig. 15—Prescribed-Item Demand-Rate Distribution
Mechanized infantry battalion; 750 prescribed items.

others perhaps should be dropped from the required stockage category. The peacetime efficiency of the prescribed items shows room for improvement, but the overall peacetime accommodation (21 percent) is surprisingly high considering that the items were selected primarily on the basis of estimated combat requirements and that many are associated with low-density end items.

Chapter 5

PRESCRIBED LOAD LIST COMPOSITION ALTERNATIVES

In this chapter a simplified model of the stockage process has been used in conjunction with the available demand data to analyze and compare major alternative policy choices on PLL composition that are available to the Seventh Army. Following the notation of certain basic considerations, the implications of alternative policies on stockage criteria and prescribed items are examined, implications for combat readiness are considered, and the basis for a uniform policy on PLL composition is presented. The objective has been to define a policy for stockage of repair parts at the organizational level that will improve the combat readiness posture of Seventh Army units.

BASIC CONSIDERATIONS

Some basic considerations in the formulation of PLL policy derive from the problems posed by the categories of stockage that have been described. The recognized categories of stockage are first reviewed, therefore, and the questions regarding the status of each are identified.

Concurrent Repair Parts

Concurrent spares are selected at DA level, and neither their selection nor the policy that provides for them is questioned here. This is a temporary category for a given item in any event, and collectively such items do not normally have a significant impact on the PLL of a unit, as is shown by the PLL composition breakdowns presented. The category appears to pose no problem for Seventh Army units and is not considered further.

Demand-Supported Repair Parts

The validity of the concept of peacetime augmentation of the PLL as represented by the demand-supported component is not in question, since the ready availability of frequently used parts facilitates unit maintenance and increases the availability of equipment. The question to be resolved in this category is only that of the criteria by which selection of items is governed. Only two alternatives are considered: the criteria currently in effect within Seventh Army and those recommended by DA in AR 735-35.¹ A broader study

of the stockage-criteria problem would be desirable at DA level but is beyond the scope of this report.

Prescribed Items

The choice of stockage criteria is an important consideration in stockage composition but must be treated in conjunction with the status to be accorded the prescribed items from which unit initial PLL stockage is selected. Stockage of prescribed items may be mandatory or optional, or, for any item not also qualified for retention on the basis of the demand criteria applied to the demand-supported category, even prohibited. Because many prescribed items do satisfy demand-supported item-stockage criteria, there will be a significant number of them in the PLL regardless of the status of the category.

Mission-Essential Repair Parts

The choice of PLL-composition policy is concerned basically with the selection of stockage criteria and with the status of prescribed items, but there is a further problem in Seventh Army because of the introduction of the category of mission-essential repair parts. As indicated, this category is peculiar to Seventh Army at the organizational level and covers items not qualified for stockage in any of the other components. It is a candidate for elimination and at most should constitute a minuscule proportion of the total stockage. It is therefore treated separately from the basic policy problem.

IMPLICATIONS OF APPLYING ALTERNATIVE POLICIES

The alternatives considered here are those described in Chap. 1. To recapitulate: With respect to stockage criteria, DA and Seventh Army policies both require that an item receive three demands within a period of 100 days to qualify for addition to the PLL, but differ in requirements for retention. DA regulations require that an item also receive three demands in this period, and Seventh Army regulations require only one demand in this period to qualify. With respect to the status of prescribed items the choice ranges between the two extremes of mandatory stockage and total exclusion (except insofar as such items might qualify on a demand-support basis).

Considered here are the four principal combinations resulting from the application of these alternatives in terms of PLL size, demand accommodation, turnover rate, and PLL efficiency. The results of this comparison are summarized in Table 6 and are discussed below. The methods by which the values in the table were derived are outlined in App B. Also identified are the implications of possible intermediate variations in policy with regard to a permissive policy that admits optional prescribed-item stockage. These comparisons are made under the assumption of both ideal and degraded performance in the recording of demands. Factors affecting the value of the alternative PLL compositions during initial combat are then reviewed and a preferred policy is selected.

The policy of stocking demand-supported items alone implies the mandatory deletion of prescribed items that do not also satisfy the stockage criteria.

TABLE 6
PLL Composition Extreme Point Comparisons
(Mechanized infantry battalion)

Category	Composition policy			
	Demand-supported stockage only		Mandatory prescribed-item stockage with demand-supported augmentation	
	Seventh Army stockage criteria	Department of Army stockage criteria	Seventh Army stockage criteria	Department of Army stockage criteria
Average size	900	630	1400	1200
Prescribed items included	240	180	750	750
Demand accommodation, percent	50	41	54	48
Turnover/month (additions and deletions)				
Number of items	63	127	41	103
Percentage of stockage	7	20	3	8.6
Efficiency of PLL ^a	93	88	86	81

^aEfficiency is defined as $\frac{\text{Exp. no. of dmds accommodated by av no. of items in PLL}}{\text{Max. no. of dmds accommodated by that no. of items}} \times 100$

This policy could be specified by the major commander or it could represent a legitimate local interpretation by a unit commander under a general policy that authorizes but does not direct the deletion of prescribed items not also qualified under the stockage criteria. The policy of mandatory prescribed-item stockage corresponds to that specified in AR 735-35¹ in the absence of authorization by the major commander to delete the initial stockage items. The variation within the two major policy categories results from the consideration of stockage criteria employed in the identification of peacetime PLL augmentation. These four combinations represent the extremes available to a unit commander under a general permissive policy.

Demand-Supported Stockage Policy

Looking first at the policy based on demand-supported stockage only, under the assumption of complete and accurate recording of demand data a composition policy that relies strictly on demand data will produce an expected infantry battalion PLL of 900 items under Seventh Army stockage criteria and 630 items under DA criteria. (Figure 16 shows the relative PLL size for the various policies.) The overall turnover rate, in terms of percentage of stockage, under DA stockage criteria is almost three times that resulting from application of the Seventh Army criteria (20 vs 7). This is a direct result of the stringent DA criterion for retention. This same difference causes the size of the Seventh Army PLL to be almost 50 percent greater than the DA version.

As would be expected, the peacetime demand accommodation is significantly higher for the 900-item PLL. This PLL is also more efficient than the DA version in the sense that the expected value of demand accommodation more closely approaches the upper limit of accommodation possible from the

number of lines in the PLL. The maximum demand accommodation possible from 900 lines, as was shown in Fig. 10, is 54 percent. The expected demand accommodation based on the probability that the required line is on the PLL when a demand occurs is 50 percent. The effectiveness of the demand criteria in producing demand accommodation is thus about 93 percent, since this is the maximum performance to be attained from the given number of stockage lines

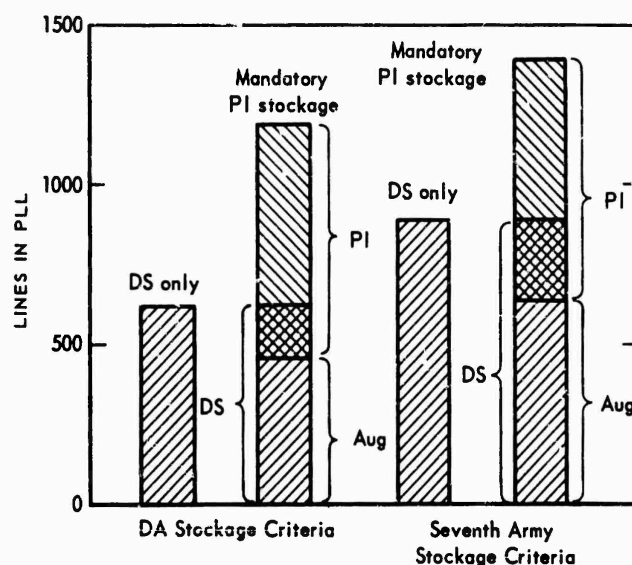


Fig. 16—PLL Size for Policy Extremes
DS, demand supported; PI, prescribed items;
Aug, augmentation items

and may be regarded as a measure of its efficiency. The corresponding efficiency of the 630 lines in the DA PLL is only 88 percent, since Fig. 10 indicates that 630 lines could produce a maximum demand accommodation of 46.5 percent. Note that the definition of efficiency used here applies to any given number of stockage lines and is not related to the problem of selecting the optimum number of lines.

Prescribed-Item Stockage Policy

The last two columns of Table 6 reflect the application of a policy requiring mandatory stockage of the prescribed items, with augmentation from those additional authorized lines that satisfy the stockage criteria. The major effects here are a significant increase in PLL size (shown graphically in Fig. 16), a moderate increase in demand accommodation, and a sharp reduction in the turnover rate expressed as a percentage of total stockage. In both cases the mandatory stockage of prescribed items produces a significant increase in demand accommodation, the greater improvement appearing under DA stockage criteria. The sacrifice in efficiency is surprisingly moderate when the increase in total stockage is considered and indicates the peacetime value of the prescribed items.

Maximum demand accommodation and stability are achieved by the combination of mandatory prescribed-item stockage and the application of Seventh Army stockage criteria. An overall efficiency of 86 percent is quite respectable when it is considered that over half the items have been selected on the basis of estimated combat requirements, which do not necessarily correspond to peacetime usage of the end items to which they apply. This performance comes at a price—namely, the requirement to stock a comparatively large number of lines. The overall demand accommodation is perhaps disappointing relative to the number of items required, but even 1400 lines represent less than 14 percent of the total possible variety of 10,000 or more different items that are likely to be required during a 2- or 3-year period in the lifetime of the unit.

Intermediate Policy Choices

Only the extremes of policy have been examined so far. In case a truly permissive policy is prescribed, the performance and size of an individual unit PLL will fall within the range of demand accommodation and size values identified here. The resultant values will depend on the manner in which the option with regard to prescribed items is exercised. These regions are plotted qualitatively in Fig. 17 for both the Seventh Army and DA policies on stockage

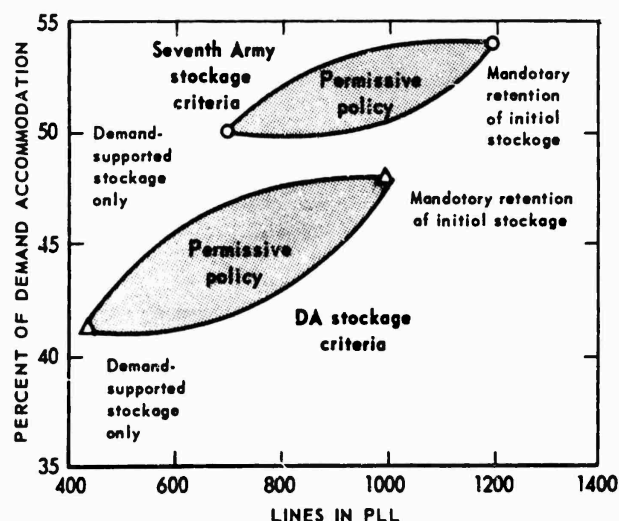


Fig. 17—Performance-Size Regions for PLL
Peacetime conditions.

criteria. Any point within the regions represents a possible combination of PLL size and demand accommodation for each of the alternative stockage criteria. The boundaries of the regions are defined by the manner in which prescribed items are added to stockage. If most active items are added first, for example, the addition of a small percentage of the prescribed items will increase demand accommodation appreciably, as described by the upper boundary. Adding least active items first will have the reverse effect, as illustrated by the lower boundary.

These boundaries are based on empirical data and reflect at least three effects in unknown proportions. Some of the prescribed items that showed no usage represent superseded stock numbers not discovered in the data collection; some represent valid combat requirements for items supported in low density or which receive very little peacetime usage comparable to combat conditions; and finally, some represent poor choices of items and should be deleted from the prescribed item list of the associated end item. The fact that the maximum demand accommodation can be achieved with fewer items than are called for under a mandatory stockage policy indicates that there may be room for improvement in the selection of prescribed items. The extent of the potential improvement is not known, but methods of achieving some improvement are discussed in another section.

Effect of Partial Demand Recording

The comparisons presented were based on the assumption of full recording of demands and hence represent upper bounds on size and demand accommodation. It is interesting to examine the effects of more realistic stock record section performance. It will be recalled that a sample of 25 units disclosed that an average of only 55 percent of the demands were actually transferred to the record from which reviews for stockage are made. Figure 18

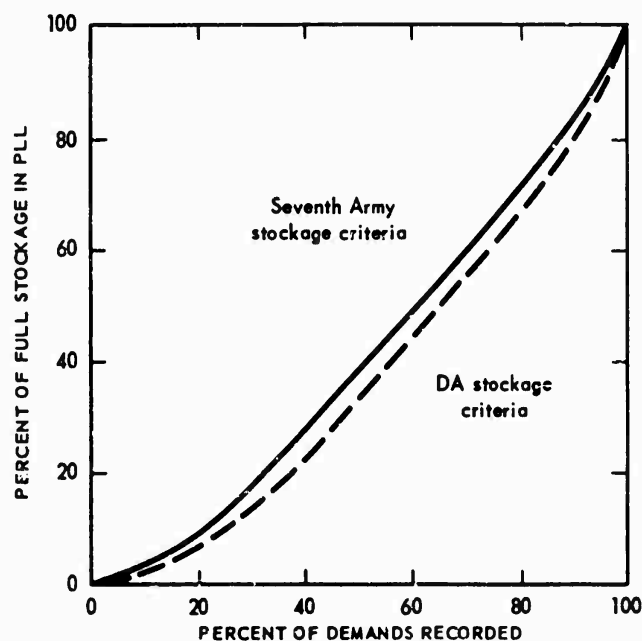


Fig. 18—Relative PLL Size as a Function of Demand-Recording Performance

illustrates the effect that partial demand recording has on stockage. The base for the percentage of full stockage is the estimated size of the demand-supported component, given full reporting of demands—i.e., 900 and 630 items for Seventh Army and DA criteria respectively. The relations shown are based on the

assumption that the percentage of demands recorded is basically the same for all lines—i.e., that failures to record are distributed uniformly over the lines—and that the apparent demand rate is depressed in proportion to the percentage of demands recorded. In the case of an item having a true demand rate of 6 demands per 180 days, for example, recording only two-thirds of the demands will make it appear that this line has a demand rate of only 4 demands per 180 days. Hence the probability that it will be in the PLL corresponds to the apparent rate rather than to the actual rate. The curves of Fig. 18 were constructed by determining the expected size of the stockage component based on the distribution of apparent demand rate among the active lines. Note that the relation is not linear and that the percentage of stockage in the PLL lags behind the percentage of demands recorded.

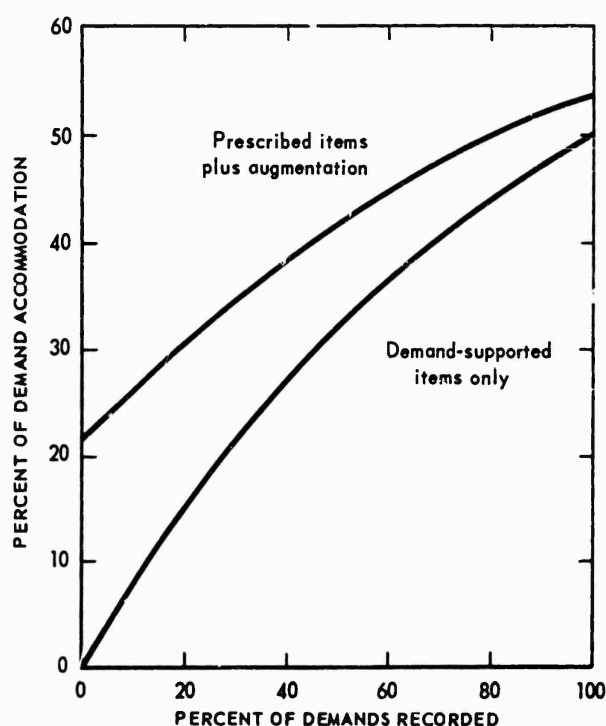


Fig. 19—Demand Accommodation as a Function of Demand-Recording Performance under Seventh Army Stockage Criteria

A more meaningful implication of the degradation in record keeping is seen in the effect it has on the peacetime demand accommodation. These effects are plotted in Figs. 19 and 20 for the four extremes of stockage policy that have been considered above under the assumption of full recording of demands. Under a policy of reliance on demand-supported stockage alone there is a severe degradation in demand accommodation independent of the stockage criteria. The value of prescribed-item stockage in the accommodation of demands is indicated by the upper curves in these two figures. The presence of

these items considerably offsets the loss in demand accommodation that would result from the incomplete recording of demands. The relative improvement deriving from the inclusion of prescribed items increases with decreasing recording performance, and in the extreme case, viz, prescribed items with zero demand recording, guarantees a minimum of about 21 percent demand accommodation in peacetime. In view of past experience and the probable continuation of personnel problems such as high turnover, lack of training, lack of experienced supervisory personnel, and related problems, the importance of a prescribed load of repair parts in providing at least reasonable peacetime-maintenance support and insurance against emergency combat requirements is magnified. A further point with regard to these items is that over 75 percent of them are functional items essential to the continued operation of the end item and whose failure will deadline the item. As such the prescribed items

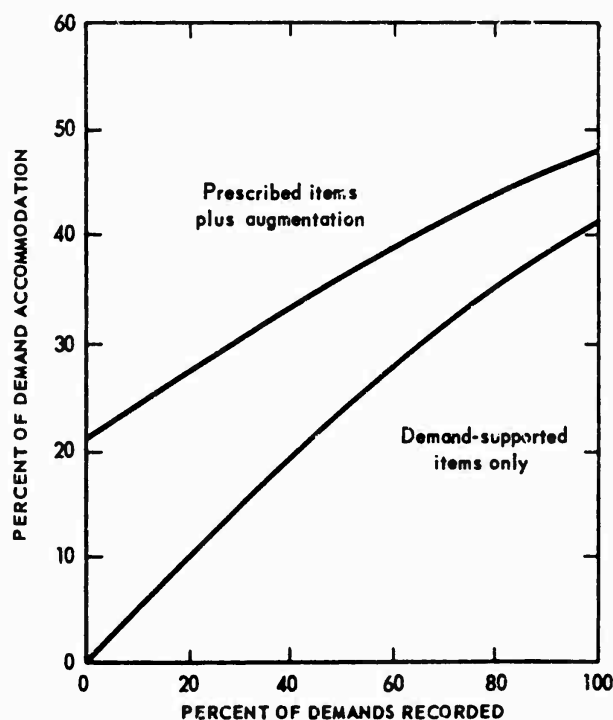


Fig. 20—Demand Accommodation as a Function of Demand-Recording Performance under DA Stockage Criteria

provide potential relief of equipment deadline and greater overall availability of equipment. This constitutes an important contribution to combat readiness, since the unit must fight with the operable equipment on hand when an emergency arises.

In summary the peacetime efficacy of prescribed-item stockage is surprisingly high in view of the fact that selection is based on estimated combat requirements and is largely independent of the density of the associated end item in the unit. Virtually all the functional items designated as initial-stockage

items are listed in the manuals as required for all densities. The fact that an item is prescribed stockage does not imply that it is expected to contribute significantly to peacetime requirements. As a group, however, these items provide a major contribution to the accommodation of unit requirements. Their potential value during the initial stage of combat is reviewed next.

Combat-Readiness Considerations

A unit's repair-parts stock makes its contribution to combat readiness in terms of operable equipments on hand before deployment of the unit at the outbreak of hostilities. Once combat begins, however, a more critical function is performed in maintaining the highest possible proportion of the unit equipment operable during the initial phases when contact with the supporting DSSA is likely to be interrupted. Under these conditions its parts load constitutes a "fly-away kit" whose function is to sustain the unit until contact with and service from the DSSA is reestablished. The increasing emphasis on unit dispersion, mobility, and independent operation under the threat of nuclear attack indicates that the parts load may continue to be critical to the operation of the unit in later periods as well. Aside from the question of stockage criteria the major issue to be resolved here is whether the potential value of the prescribed items is sufficiently great to warrant their stockage at the unit independent of their qualification on a peacetime, demand-supported basis.

It is reasonable to assume that selection of prescribed items is made in a careful and competent fashion, but it is also reasonable to question the ability to accurately predict combat requirements. Basically the prescribed items are intended to satisfy two criteria: they must be functional items whose failure will deadline an end item, and they must have relatively high estimated usage under combat conditions. The equipment designers and those responsible for development and acceptance testing are most competent to judge whether the failure of a part or component will render the end item incapable of performing its combat mission, and they are also best qualified to provide the initial estimates of mortality under combat conditions.

The high peacetime usage and demand accommodation of prescribed items clearly implies the basic validity of this class of stockage. These items will be no less valuable during combat, and, since they are predominantly functional items (i.e., potential deadlining items), they are required to be on hand in the unit if it is to keep its equipment operable during initial combat and periods of independent operation. The prescribed-item concept is sound and the implementation of this concept in the form of the TM parts lists has been effective as evidenced by the high usage level. Stockage of these items at unit level is justified and the remaining problem is to seek additional ways to update and improve the associated listings.

The stockage of prescribed items can make a fundamental contribution to combat readiness, but this potential is not fully realized when selection for stockage is limited strictly to demand-supported items. As has been shown in Fig. 6, only about one-third of these items may be expected to appear on a PLL constructed on a pure demand-frequency basis using Seventh Army criteria, and even fewer would appear under application of DA stockage criteria. There has been a trend toward strict reliance on demand frequency as the only valid indicator of unit requirements under all conditions. Although it is true that

demand frequency is an excellent indicator of stockage in support of peacetime maintenance operations, this approach has significant deficiencies as a guide in selecting the items to sustain the unit when it must operate independently. In view of these recent trends and an apparent lack of appreciation of the associated difficulties, it is appropriate to examine in more detail a few of the deficiencies inherent in a policy that relies solely on a simple demand-frequency criterion in the selection of stockage items.

To establish the context, consider only those end items in the unit that are designated by DA as being the hard core of weapons, vehicles, and supporting equipment essential to the performance of the unit mission. In a mechanized infantry battalion, for example, there are about 94 such items out of more than 200 line items listed in the TOE. These end items are supported by the unit in a variety of densities. In some cases, at least, the fact that a mission-essential end item is available in a comparatively low density makes it more critical to the unit than an equipment that is available in large numbers. Loss of a machine-gun or even an APC due to parts failure may conceivably result in less degradation of the overall combat effectiveness of the unit than the loss of a single generator if that generator is the only one available to the unit for performing the required function. The use of a single set of criteria for the selection of

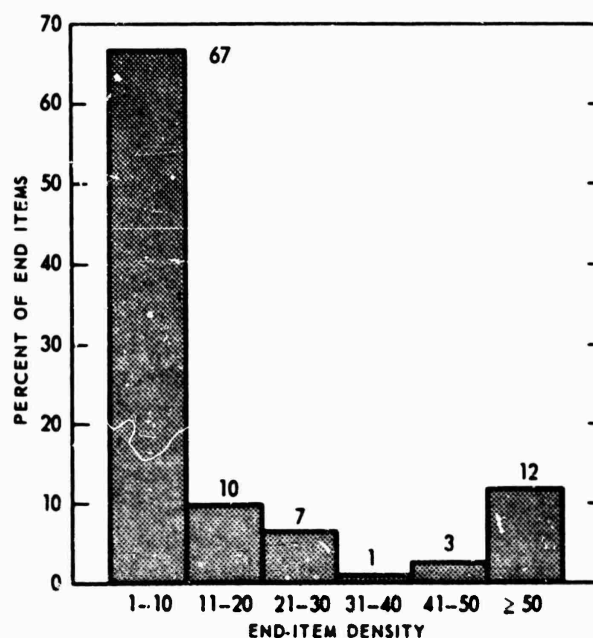


Fig. 21—DA Mission-Essential End-Item Density Distribution
Infantry battalion, 90 to 100 end items.

stockage completely ignores the problem of end-item density within a single unit. Figure 21 illustrates this problem by plotting the distribution of end-item density in a mechanized infantry battalion for those "move, shoot, and communicate" equipments declared essential to the unit mission by DA. These are the same items reported in the Unit Readiness Report as the "equipment-on-hand"

section. It is seen that fully two-thirds of these items are supported in a density of 10 items or fewer. Clearly such end items will not generate demands at the rate to be expected from items numbering 50 or more. It is unlikely that critical parts for these items will be recognized by demand criteria that are established without regard to end-item density. In a PLL that relies strictly on demand-supported repair parts, such end items will not receive adequate parts coverage.

Use of a single set of demand criteria for the selection of stocks to augment a basic list of items is entirely practical where the objective is merely to facilitate peacetime maintenance operations and where the deciding factor is simply frequency of need. As a criterion for selection of items that will best support all the essential unit equipment in combat, however, it is inadequate. A simple demand criterion takes no cognizance of the nature of the part or item. Seat cushions and reflectors, for example, are listed along with carburetors, water hoses, and firing pins. A vehicle or weapon can perform its combat mission without the former but not without the latter.

Let it be assumed for the moment that no listing of prescribed items exists and that it is desired to establish criteria that will assure adequate stockage of items to sustain the unit in initial combat and adequate accommodation of daily peacetime-maintenance requirements. The accommodation of peacetime requirements would be relatively simple and would result in a rudimentary set of pure frequency criteria similar to those currently in use. Special procedures would be required, however, in the review of the demand records for stockage candidates. A sliding scale of demand-frequency criteria would be required as a function of end-item density. In addition the time periods would have to be correlated with the activity or usage of the end item to take account of demands occurring during periods of training and maneuvers when equipment usage most closely approximates that expected under combat conditions. A part satisfying these refined frequency criteria would then require review to determine if the item also qualified as a functional repair part whose failure would result in the deadlining of the end item. In view of the difficulty experienced at unit level in the management of its PLL under the simpler procedures now required, it is clearly out of the question to expect adequate performance of the more sophisticated procedures outlined here.

Prescribed items are designed to relieve the unit of the requirement for the complicated procedures just discussed. Their stockage provides a uniform base, augmented to provide additional accommodation of demands posed by maintenance requirements. Prescribed items and the demand-supported peacetime-augmentation items are both required for full combat readiness. These two categories complement each other and combine to provide the means for realizing the dual purpose of the PLL.

THE BASIC PRESCRIBED LOAD LIST COMPOSITION

The previous sections have clearly indicated the desirability and advantages of incorporating both prescribed items and demand-supported augmentation in the PLL to achieve the dual purpose of the PLL and maximize its contribution to combat readiness. It will be recalled that the prescribed load of

repair parts that has been considered here is restricted to those end items and systems considered essential to the unit mission. There are other end items that currently have prescribed-item listings, but it is considered that the mandatory stockage of items in support of end items not considered reportable in the unit readiness report is inconsistent with the principle of economic stockage. These lists in some cases represent a lag in the updating of the manuals. A corollary to the mandatory stockage of any set of repair parts, however, is the requirement for the continuous review and updating of the listing of parts whose stockage is to be required. The results shown indicate that there is probably room for improving the lists by deletion of items that have not substantiated the initial mortality estimates and by the addition of items that were not originally recognized as being required. Suggested methods for contributing to the improvement of the listing of prescribed items are discussed in another section.

With the acceptance of the mandatory stockage of prescribed items for reportable equipments, the selection of the basic-composition policy for Seventh Army narrows to consideration of the appropriate stockage criteria. As indicated in Table 6, there is no great difference in the resulting net size of the PLL once the prescribed items are included. The question is simply one of determining whether the additional 200 or so lines of stockage implied by the continuation of the Seventh Army criteria are justified. As a general principle it is economical to add stockage items so long as the resulting increment in demand accommodation exceeds the corresponding increment in stockage relative to the total stockage required to accommodate all demands. Reference to Table 6 indicates that use of the Seventh Army stockage criteria will result in an increase in demand accommodation of about 6 percent as compared to that afforded under DA stockage criteria. This increase is achieved at a net increase of stockage lines of less than 2 percent (based on a total variety in excess of 10,000 items) and therefore justifies the addition. It should be noted, however, that the optimal PLL size has not necessarily been selected. The choice made here is between two sets of stockage criteria, each of which implies a particular average PLL size that is not directly controlled in terms of a specific number of lines to be stocked. The stockage lines are selected on the basis of a random demand process which provides only indirect and imprecise control over the net PLL size.

The preferred policy for Seventh Army, then, is one of mandatory stockage of the prescribed items for its mission-essential end items identified in DA 711-2,⁴ with demand-supported peacetime augmentation selected on the basis of the current Seventh Army stockage criteria. Chapter 6 shows that the implications of this policy for cost, mobility, and workload are not limiting. Whereas the stockage criteria selected here differ from those recommended by the DA, AR 711-16⁵ establishes the principle of variation in stockage criteria to achieve reasonable demand accommodation.

Some of the secondary benefits to be derived from the recommended policy are worth reviewing at this time. Beyond the provision of balanced coverage of functional parts for all end items essential to the mission of the unit, independent of density, prescribed-item stockage will introduce an element of uniformity in the PLL of like-type units that will facilitate review and management at unit and higher echelons. As pointed out earlier, prescribed items provide a

guaranteed minimum-demand accommodation during peacetime, and their contribution in this regard is enhanced in a unit in which demand recording is less than complete. The turnover rate in the stockage list is considerably reduced by the presence of a stable prescribed-item element. In the case of the Seventh Army stockage criteria, about one-third of total potential turnover is eliminated by the retention of the prescribed items independent of the demand criteria. This reduction in turnover from a relatively few stockage lines is a consequence of the fact that the distribution of demand frequency among the prescribed items does not follow the overall pattern but concentrates on the frequency ranges that produce a high contribution to item turnover. Finally the concentration of functional items in the total prescribed-item list is no less useful in reducing the deadline rate in peacetime than under combat conditions.

The use of the Seventh Army criteria in the selection of PLL augmentation stockage implies a greater number of demand-supported line items than use of the DA criteria under the assumption of ideal record-keeping performance, and Fig. 18 indicates a slightly lower sensitivity to incomplete recording of demands. It has been shown that recording performance is generally low and is likely to remain less than ideal so long as the individual unit is responsible for the maintenance of its PLL. Various programs are under way that are aimed at providing means for the support of the unit in the stock records area, but it will be some time before there is any universally available service. Under these conditions the Seventh Army criteria represent, in part, an adjustment to offset the problem of incomplete demand recording without introducing the attendant problem of excessive stockage in a unit that does achieve complete recording of demands. This is not to say that there can or should be any relaxation in command emphasis on full compliance with the established procedures. The objectives of the Seventh Army criteria, given full recording, are legitimate, but with the performance to be expected on the basis of past experience, many PLLs may actually correspond to the size intended by the DA criteria.

Another peripheral benefit of the recommended policy, and the stockage criteria in particular, is the fact that the less stringent criterion for retention will, to some degree, provide automatic coverage of seasonal items that might not be otherwise achieved. The regulations of course caution that an item that is seasonal should not be deleted from the PLL in strict accordance with the demand criteria, but this is easier said than done and introduces an additional management burden in an area where it is quite difficult to achieve satisfactory performance in even the rudimentary procedures.

A few comments regarding the question of a permissive stockage policy are in order. In general a permissive policy is useful in a situation in which the latitude permitted can be employed to achieve performance superior to that resulting from strict conformance to regulations. The means and the ability required to take advantage of special circumstances must be present. In the supply area within Seventh Army the contrary is true. Continuation of the present permissive policy will perpetuate the chaos evident in the data presented earlier in this study. Reference to Fig. 17 makes it clear that no local interpretation of a permissive policy with regard to prescribed items can produce a peacetime demand accommodation superior to that resulting from the recommended policy of mandatory stockage. Regarding peacetime efficiency

it would appear that the maximum attainable demand accommodation could be achieved with fewer stockage lines than called for under the recommended policy. It must be remembered, however, that the primary function of the prescribed items is to sustain the unit with functional repair parts during initial combat and periods of independent operation. The fact that a prescribed item does not contribute greatly to peacetime demand accommodation does not invalidate its potential value in combat. The attendant sacrifice in peacetime efficiency required to provide balanced parts availability is illustrated by the nature of the upper boundaries of the regions plotted in Fig. 17. The net result is a peacetime efficiency of about 86 percent as opposed to the limit of about 93 percent that could be achieved through demand-supported stockage only. Moving along the upper boundary toward the combination of size and peacetime demand accommodation to the point representing the recommended policy, combat readiness continues to increase even though the peacetime accommodation limit has been reached at a lower net PLL size. In the case of PLL stockage, continuation of the present permissive policy can lead only to the degradation of unit combat readiness relative to the standard attainable under the recommended policy.

MISSION-ESSENTIAL REPAIR-PARTS STOCKAGE

As indicated, the mission-essential repair-parts category at organizational level is unique to the Seventh Army. Its aim appears to have been to enable the unit commander to stock a very limited number of parts that he considers essential to his mission because of special circumstances or local conditions and that would not qualify under any other criteria. Under proper control this component of the average PLL would account for only a very small number of lines. But control has not been adequate and the authority to stock items in this category has clearly been misused. In many cases this category apparently has been relied on as a substitute for proper management of the PLL and in some cases it has been resorted to as a device to improve the REDCON rating (see Chap. 7).

Figures 1 and 2 showing units with 300 and 400 mission-essential parts substantiate the foregoing observations. In such units it is more than likely that many of these items actually qualify for stockage under one of the generally recognized categories. The present Seventh Army regulation in fact permits a combat-essential or prescribed item to be stocked under the mission-essential category.

The mission-essential category could be eliminated without significant reduction in combat readiness if stockage of prescribed items were mandatory and proper emphasis were given to the recording and analysis of demand data. Those units that have employed this category as a sort of qualitative demand-supported component in the absence of adequate records might suffer a temporary loss of needed parts. The long-range effect, however, would be beneficial.

An alternative solution is to purge the current PLLs of all such parts except those that legitimately qualify for other components thereof and to institute a rigid control over the category. Under current regulations a unit

commander need only provide justification and request authorization from his supporting DSSA to stock a part as mission essential. The DSSAs, which have authority to grant such requests, obviously have not applied very stringent criteria because they have generally given assent. A stricter control over the use of this category would clearly call for changes in procedures, perhaps along the following lines. If a unit commander discovered that a repair part was essential to his mission it would be his responsibility to recommend to the appropriate materiel command that the item be added to the list of prescribed items for the equipment affected. His recommendation should indicate that the item is a functional repair part and describe the conditions under which the requirement was discovered. Interim authority to stock the item might be granted by the Seventh Army pending DA action on the recommendation. Seventh Army has a convenient instrument for the review and tentative approval of such requests in its CSMI Team. If the materiel command approved, all units supporting the associated end item would then stock the part and the initiating unit would merely change the coding of the item in its PLL. If the materiel command denied the request, stockage authority would be withdrawn subject to appeal by the unit commander. Such a procedure, in addition to imposing a more rigid control over additions, would also encourage participation by unit commanders in the upgrading of the prescribed-item lists.

As a corollary to identification of candidates for addition to the prescribed-item lists, action could be taken at Seventh Army level to recommend deletion of existing prescribed items that were not used during a period of one year. This analysis could be performed at the Seventh Army ICC by matching a consolidated list of Seventh Army's prescribed items against the ICC stock list and fringe file. Prescribed items not matching either list would then become candidates for deletion, and if review confirmed the machine result, Seventh Army should recommend deletion to the appropriate materiel command.

User experience is a logical source of prospective additions to the prescribed item lists, since exercises and other training activities can identify vital items that have been overlooked in the initial selection. Candidates for deletion, however, are best selected on the basis of highly consolidated data to ensure that an appreciable amount of combatlike operation is represented in the consolidated history of each end item.

STOCKAGE QUANTITY CONSIDERATIONS

Two minor aspects of PLL policy relating to authorized stockage quantities are pertinent to the study and require comment. These are the minimum quantity of an item to be stocked and the initial-stockage quantity for items having application to more than one piece of equipment.

Minimum Stockage Quantity

There is an apparent difference between Seventh Army and DA regulations governing the minimum quantity of an item to be stocked. The Seventh Army regulation specifies a minimum-stockage quantity of two for all stockage categories except mission essential. Strict interpretation of AR 735-35¹ on this subject results in an authorized stockage quantity of one for many prescribed

items. The apparent discrepancy is explained by a time lag in the revision of the TMs. AR 735-35 directs that the initial stockage quantity for prescribed items shall be that shown in the TM for the appropriate equipment density supported by the unit when a numerical value is given in the allowance column. Many current 20P TMs specify a quantity of one for prescribed items in the authorized stockage allowance column. Not all these TMs have been revised, however, to reflect the changes in AR 700-18,³ which governs the preparation of the stockage lists in the 20P TMs. It is clearly the intention of this regulation that the minimum stockage allowance to be entered in the TMs is a quantity of two. AR 735-35 confirms this in specifying a minimum initial stockage quantity of two in those cases in which the quantity must be computed by the unit from a factor for each 100 equipments supported. It is further confirmed by the fact that the table in AR 735-35 for the determination of the stockage quantity for demand-supported augmentation items also specifies a minimum quantity of two. The Seventh Army practice is thus consistent with the intent of DA regulations.

The policy on stockage quantity is an important aspect of PLL policy in general because of its implications for the incidence of zero balances. A brief analysis of the problem was made before the revised DA regulations were available, when it was thought that a genuine conflict between Seventh Army and DA regulations existed. The results, which are summarized here, confirmed the wisdom of the current policy.

As shown in Chap. 3 (Fig. 14), demand quantity distributions indicate that, overall, items satisfying the criteria for demand-supported stockage fall into authorized-quantity groups such that about 40 percent of the demands are for quantities equal to or greater than that authorized for stockage. This estimate was based on the assumption of a minimum-stockage quantity of two. If this requirement were removed, and items with demand quantity sufficient to justify a quantity of only one (for 15 days' consumption) were stocked in that quantity, the proportion of demands that would equal or exceed the authorized quantity would climb to 81 percent—double the previous value. Over half the demands in the sample were made against items that, except for the arbitrary minimum, would have an authorized stockage quantity of one, which accounts for the great increase in the percentage of demands that equal or exceed the authorized quantity. The result would be to roughly double the number of lines at zero balance at any given time. This can be severe in the environment of short supply that currently exists and has obvious implications for readiness.

A survey of 414 prescribed items listed in the July 1965 edition of TM 9-2300-223-20P² indicated that about 72 percent of these would be stocked in a quantity of one in the absence of an arbitrary minimum and thus would further compound the problem of zero balances. The items selected were those applying to the equipment of a mechanized infantry battalion. The results stem from the fact that the TM was published before the revision of AR 700-18.³ Presumably the allowances will be adjusted according to the revision of the latter.

In any event the superiority of employing a minimum-stockage quantity of two is quite evident. Seventh Army has long recognized this fact and incorporated this feature into its supply regulation. The fact that 40 percent of the demands exceed the authorized quantity, even with a minimum-stockage quantity

of two, suggests that further improvement is possible in the selection of stockage quantities. This subject has not been pursued in this study, however.

Stockage Quantity for Multiple-Application Repair Parts

DA instructions as contained in the October 1965 edition of AR 735-35¹ are also at variance with Seventh Army instructions for determining the initial-stockage quantity of repair parts applying to more than one piece of equipment. The DA regulation specifies that the stockage quantity for an item having multiple application should be the sum of the initial-stockage quantities determined for the appropriate densities of the individual equipments. The Seventh Army regulation specifies that the stockage quantity is to be based on the combined density of the different equipments.

A comparison of the two methods was made, using the same 414 tank-automotive prescribed items referred to above. For each item having multiple application the authorized quantity was determined by both Seventh Army and DA rules. About 28 percent of these items (117) apply to more than one end item, and the stockage quantity is different for about 18 percent (76) of the items in the sample. The DA method results in a negligible reduction in the lines stocked (less than 1 percent) and a 7 percent increase in the total number of repair parts. Since the differences are small, since additional parts improve readiness, and since the computation of initial stockage is simplified, it is concluded that the DA method should be used in the event that mandatory prescribed-item stockage is implemented in Seventh Army.

SUMMARY OF THE PREFERRED POLICY

Based on the foregoing analysis, it is concluded the the preferred PLL policy for Seventh Army should include the following:

- (1) Mandatory stockage of the prescribed items qualifying for initial stockage in the unit.
- (2) Continuation of the Seventh Army criteria for the selection of the demand-supported augmentation component of the PLL.
- (3) Elimination of the mission-essential repair-parts category, or purging of mission-essential parts from current PLLs followed by strict control.
- (4) Continuation of the stockage of concurrent repair parts as appropriate.
- (5) Stockage of all items in a minimum quantity of two.
- (6) Computation of the initial authorized stockage quantity for multiple-application items in accordance with the instructions of AR 735-35.¹

Chapter 6

OTHER IMPLICATIONS OF THE PREFERRED POLICY

The characteristics considered essential in the selection of a preferred PLL policy have been developed in the preceding chapter, and the implications of the preferred policy with regard to composition, demand accommodation, efficiency, and readiness have also been discussed. To recapitulate: The adoption of mandatory stockage of prescribed items for mission-essential equipments and the use of current Seventh Army stockage criteria in the selection of demand-supported peacetime-augmentation items would generally result in varying increases in the size of unit PLLs. The size of a mechanized infantry battalion PLL, for example, would be approximately 1400 items (given full demand recording) as compared with that of existing lists such as the standard infantry battalion PLL of the 3d Inf Div, which contained about 730 items in mid-October 1965. Considerable improvement in demand accommodation could be expected. The PLL just referred to provided about 35 percent demand accommodation for the consolidated demands of the seven battalions to which it was applied, whereas the preferred policy is expected to provide about 54 percent accommodation (again given full demand recording). Actual performance may fall short of this goal, but the importance of the prescribed items in limiting the degradation in accommodation has been indicated. The 86 percent peacetime "efficiency" of the preferred policy PLL (relative to the maximum accommodation attainable with the same number of lines) compares favorably with the value of about 93 percent characteristic of a purely demand-supported PLL, considering that over half the items are selected on the basis of estimated combat requirements rather than actual peacetime usage. Under the preferred policy the prescribed items and the demand-supported augmentation will comprise the dominant components of a unit's PLL; concurrent repair parts and mission-essential repair parts (if this category is retained at all) will normally constitute a negligible fraction of the total PLL. Finally the preferred policy has been shown to provide the greatest contribution to combat readiness that is achievable from the alternatives available to Seventh Army at this time.

There are additional implications for the Seventh Army of adopting mandatory stockage of prescribed items that must be considered in conjunction with those just summarized. The most important of these are cost, mobility, and workload. These are dealt with in turn in this chapter. Finally a review of the implications of mandatory prescribed-item stockage for readiness is provided, since combat readiness is the overriding consideration in the choice of this feature.

COST

An accurate determination of the funding impact at organizational and direct-support levels would require a detailed comparison of current stockage lists with the prescribed loads. Such a comparison is impossible because very few units now have an accurate listing of prescribed items for their equipment. To determine the funding impact would require the listing of mandatory prescribed stockage of each unit, a unit-by-unit evaluation of parts requirements to fill out the list, and determination of the associated dollar value. This task would be equivalent to that required to implement a mandatory stockage policy.

Such an effort was out of the question for this study. It has been possible, however, to make a rough estimate of the dollar value of stocks that would be required to accomplish mandatory stockage. This involved essentially two steps. The average dollar value per line was determined for combat-essential items in a mechanized infantry battalion and an armored battalion, based on the prescribed items actually included on the list of typical units. These average line-item costs were then applied to about 90 battalion- and company-sized units in the V and VII Corps. These units were selected so as to represent the entire range of stockage practices employed in Seventh Army, and estimates were made of the additional line items needed over and above those already carried. The result was an estimated Army-wide cost of about \$6 million at unit level and \$3.6 million at the DSSA level. This would be the incremental cost of adding the necessary prescribed items to accomplish mandatory stockage. It is a crude estimate, and it is acknowledged that the true value may well deviate considerably from these figures.

Both funding and line-item impact at the Seventh Army ICC and COMMZ Inventory Control Point (ICP) level are expected to be negligible in view of recent action taken to include all combat-essential items in stockage at those levels. There would be no effect on the requisitioning objective at either level since the requisitions associated with carrying out the recommended policy would be coded as nonrecurring.

To put the cost implications in perspective at unit level, it is instructive to compare the dollar value of the initial stockage for a mechanized infantry battalion with the dollar value of the annual repair parts consumption of such a unit. The value of initial stockage is about \$13,000, whereas that of the average annual consumption is about \$175,000. These are estimates based on an average dollar value per line and per part together with the consumption data shown in Table 3. The total dollar value of the initial stockage of prescribed items is thus less than 10 percent of the value of annual consumption. This is a one-time cost relative to the operational lifetime of each piece of equipment to which the items apply.

The dollar cost of reinstating full stockage of the prescribed items (the regulation requires stockage for a minimum of one year) is important in establishing budgetary requirements for the period over which the action is taken. It is not relevant to the selection of the preferred policy. Initial stockage as prescribed in AR 735-35¹ constitutes an investment committed at formation of the unit similar to the equipment investment. Reinstatement of these stocks merely constitutes deferred replenishment of items consumed.

MOBILITY

There is sufficient evidence that units would experience no difficulty at all in carrying the load associated with a policy of mandatory stockage of prescribed items and that they probably would also be able to carry most of the augmentation items that qualify for inclusion on the basis of demand. This is based in part on a survey of the mobility status of units in Seventh Army, conducted by the CSMI Team, and in part on DA guidance as to the relative status of the various authorized components of stockage.

The Seventh Army survey showed, for example, that 33 of 39 units tested could carry their entire current PLL stock. Items in zero balance do not affect this result because a storage location is maintained so long as the item remains on the stock list. In most cases the size of the current poorly constructed PLL, including all components, exceeds the size of the prescribed items component. The lack of complete mobility in the six cases was caused by a few bulky items such as truck tires, gas tanks, tail gates, bumpers, radiators, troop seats, and truck sideboards. With the exception of truck tires, none of these items is listed in the consolidated tank-automotive TM 9-2300-223-20P² as an element of the initial prescribed load, although all these exceptional items are automotive parts. The survey concluded that all the units visited could transport all the prescribed items, concurrent spares, and, indeed, virtually all the additional demand-supported items, except that the stockage quantity for bulky items might have to be restricted to a value below that authorized on the basis of demand. This excess (relative to transportability) could either be turned in to the DSSA or be retained at the unit as floor stock exempt from the requirement for transportability in the event of an emergency.

It is clearly the intent of DA regulations that the unit carry its prescribed items and that these should therefore have first call on mobility. There is in fact no stated requirement for the mobility of the augmentation component, which is based on peacetime demand. Any sacrifice in mobility, therefore, should come from the nonfunctional items in the demand-supported component of the peacetime PLL. Floor stockage of such items is economical since it provides ready unit access to those parts required to keep the end items of the unit in a high state of readiness in anticipation of an emergency. When the emergency actually arises this stockage has already performed its function and need not necessarily be carried with the unit when it moves out of garrison.

Mandatory stockage of prescribed items may thus require minor rearrangement of storage locations or restriction on some portions of the nonfunctional demand-supported stockage. Mobility is not, however, a limiting factor in the decision to require stockage of prescribed items.

WORKLOAD

Unit Level

Adoption of the recommended stockage policy will affect workloads in two respects: (a) in the preparation of the full list of prescribed items and (b) in

the maintenance of the larger list. The initial impact will vary from unit to unit, depending largely on past stockage policy and the condition of unit records. An upper limit is available for the workload involved in preparation of the list and comparison with the current PLL to determine the incremental requirement. It is estimated that approximately one man-month of effort would be required for the complete process of determining the latest applicable 20P series TMs, listing the prescribed items by end item, preparing the consolidated initial prescribed load list, and comparing it with existing PLLs to define the items to be requested. This estimate is based on the experience gained at Seventh Army Headquarters in actually carrying out this process for the TOE equipment of a mechanized infantry battalion. This workload may be greatly reduced or virtually avoided in those units that continue to identify the basic status of all items on the current PLL, currently stock all or the majority of the prescribed items, or at least have not lost the listings made in response to an earlier directive (subsequently rescinded) to stock all prescribed items. The total elapsed time involved will depend to a great extent on the local availability of the required TMs. Given the complete set of needed documents, the effort required to extract the associated parts list is not great. Moreover it is essentially a one-time effort.

At DA level, consideration is being given to the preparation of a computer program that would accept a listing of the end items on hand in a unit together with the density of each and produce a consolidated listing of authorized stockage quantity for each line. Since it may be necessary to delay implementation of the proposed policy if it is adopted, it might be possible to accelerate this effort to the point where it could be utilized by Seventh Army. If such a service were available, the workload would be greatly reduced and accuracy and completeness substantially improved.

The increase in the number of lines carried on the PLL would result in a continuing workload at the unit level subsequent to the actions necessary for the initial implementation. If, however, the occasion were taken to carefully review the remaining stockage at the same time, it is likely that some of the additions to stockage could be offset by the deletion of lines in the mission-essential category. There is good reason to believe that mandatory stockage of the prescribed items would largely eliminate the necessity for carrying any significant number of such items. In some units this could result in the elimination of from 100 to 400 line items (assuming none actually qualifies for another category).

Methods to improve management are under study within Seventh Army and elsewhere. The primary feature of these methods is to relieve the unit of a great deal of its management and review responsibilities. If these methods were to reach development before the establishment of the proposed stockage policy, the workload impact, initially minimal, might well continue to be so.

DSSA Level

The initial workload at the DSSA level would consist primarily of review of the revised PLLs submitted by supported units, to ensure inclusion in the ASL of all PLL items except those in the mission-essential category. There would of course be one surge in workload connected with the processing of the nonrecurring demand of the units as they request new stockage items and also

as they requisition parts for addition to the DSSA ASL. And of course there would be some increase in the workload resulting from the increase in the number of lines of stockage to be managed.

Army and COMMZ Levels

Other than the one-time surge in requisition load resulting from unit and DSSA requisitions for initial stockage, there would be no continuing effect on the workload at either the Seventh Army ICC or COMMZ ICP level. Authorized stockage lists would not be significantly affected at these levels. Even the impact of the nonrecurring demands would be minimal in that the requisition would be in urgency-of-need category D, and the processing of such requisitions is almost completely automated at these levels. The requisition-processing surge would of course be followed by a corresponding increase in shipments to the units and DSSAs, but this effect would be attenuated owing to time spread. The effects here can be minimized by controlled enforcement of the proposed policy so as to anticipate the coming requirements and to distribute the submission of requests over an extended period. These items are virtually all current stockage items in Seventh Army and COMMZ so that what is required is a temporary authorization to order in excess of the existing requisitioning objective.

READINESS

In assessing the effect of mandatory stockage of prescribed items on readiness it should be emphasized that the term "readiness" is used here in the context of the intent of the DA regulations with respect to the purpose of prescribed items (not in the context of the so-called REDCON report). As indicated elsewhere in this report, the usefulness of prescribed items is really twofold. First, and most important, it provides insurance against expected interruption in supply support in the first stages of combat operations by enabling the unit to keep equipment in operable condition through the use of its own basic kit of parts. This purpose is in accordance with the long-standing basic DA policy that was designed to maintain the capability of the unit in combat. This policy is spelled out in both the specific directions appearing in TM 9-2300-223-20P² and in the governing regulations such as AR 735-35,¹ AR 700-18,³ and AR 320-5.⁶ Second, the prescribed items help the unit keep its equipment off deadline and operable in anticipation of combat by complementing the demand-support component of the PLL and providing needed items that might not be available because of poor demand reporting. This second purpose follows from the fact that the prescribed items are predominantly functional repair parts and hence potential sources of end-item deadline.

The value of prescribed items in combat cannot of course be predicted accurately. Their potential in this respect, however, is evident in the way they fulfill their secondary function, i.e., in improving peacetime operation and, consequently, readiness. Experience in Seventh Army shows a high (exceeding 80 percent) usage for these parts and an accommodation of demand that is nearly three times the average accommodation of the total active line items. Thus prescribed items are not dead stockage. They provide a genuine contribution to peacetime readiness in addition to preparation for the initial stages of combat.

The readiness implications are also apparent in the shortcomings of the system of demand support with respect to end-item density. There is wide variation in the end-item density within a unit, although a single criterion is applied in the selection of stockage for end items supported by the unit. In a mechanized infantry battalion, for example, fully two-thirds of the reportable end items are supported in a density of ten or less. These are the end items officially designated by the DA as the "move, shoot, and communicate" end items essential to the combat mission of the units. Clearly, peacetime demand with a stockage criterion designed to identify only very high-usage parts is not adequate to provide repair parts protection for these items.

Another failing of peacetime demand as a valid indicator of combat requirements is the possible disparity between usage in peacetime and usage in combat. This problem varies considerably with the end item and is most pronounced with regard to weapons. While virtually all equipment is exercised under conditions approximating combat, the stockage criteria and required record keeping are not sufficiently sophisticated to separate out the relevant experience and develop meaningful coverage adequate for combat requirements, which is the basis for the determination of the prescribed load.

Finally even the current simplified requirements for the collection and processing of demand data appear to be beyond the capabilities of a majority of the units. Unit performance in the management of its PLL has been notoriously poor, the major failing being the inability of the units to keep demand histories accurately and completely. Mandatory stockage can protect the unit from the effects of inadequate PLL management to a large extent and thus provide a major contribution to readiness. In sum, it is concluded that mandatory stockage of prescribed items would significantly improve the combat readiness of units and the ability to maintain equipment in operable condition in the early stages of combat.

Chapter 7

UNIT-READINESS REPORTING AND THE PRESCRIBED LOAD LIST INDICATOR

The implications of unit-readiness reporting criteria for PLL and stockage management have been suggested previously. In this chapter the Unit Readiness Report and its relation to PLL stockage is discussed in more detail. It is shown that current reporting criteria have the effect of discouraging good performance in the unit-supply area when a single prescribed load of repair parts is employed as a working stock, as is now the case. Possible solutions to the problem are suggested.

THE UNIT READINESS REPORT

The Unit Readiness Report (DA Form 2715) is a DA-required report designed to indicate the operational readiness of units to perform, at the time prescribed in approved plans, the mission specified in the TOEs under which they are organized. It has three major sections, covering various aspects of personnel, training, and logistics. It is prepared quarterly by every unit and is forwarded to the next higher headquarters. The reports are consolidated at higher commands and are ultimately submitted to the DA.

The completed Form 2715 determines the unit's REDCON, purporting to measure the level of readiness in terms of criteria laid down in AR 220-1⁷ and put into effect by USAREUR 2 November 1965. The REDCON is related to the Readiness Capability (REDCAPE) assigned to the unit. The REDCAPE is the level of readiness that is judged to be within the capability of USAREUR to support with programmed and allocated resources. Each unit commander naturally strives to achieve a REDCON rating that equals or exceeds his assigned REDCAPE because this rating is employed as a measure of his ability to manage the resources provided him. There is a very real pressure exerted on the unit and higher commanders to achieve a high operational readiness as measured by the Unit Readiness Report and consolidations thereof. This pressure is generally beneficial so long as the criteria used in reporting unit readiness encourage performance that will lead to real combat readiness. As will be pointed out, there are indications that the criteria for reporting the status of PLL stocks are deficient in this respect.

There are 10 readiness indicators distributed over the three major sections of the readiness report, each with an assigned numerical value of either

1, 2, 3, or 4 in accordance with instructions in the associated regulations. A rating of 1 is the highest achievable. One of the indicators that appears in the logistics section evaluates the status of PLL stocks in terms of the number of lines at zero balance on the reporting date. Although this is only one of several conditions rated in the report, the method of determining the overall unit REDCON assigns equal importance to all indicators. The final unit rating is determined by the lowest rating assigned to any of the indicators. Thus a unit with nine indicators evaluated as 2 and one as 4 receives an overall unit rating of 4.

The PLL indicator has attracted considerable attention recently because it has frequently been the deciding factor in establishing the REDCON rating for units that have not met their assigned REDCAPE. To avoid classification of this report, details of the assigned readiness levels and reported actual levels are not given here. It suffices to note that the generally unsatisfactory results have focused attention on the repair-parts-supply system in general and the PLL situation in particular. The readiness report has performed its intended function to the extent that it has identified a genuine problem area. Repair parts have been in short supply within Seventh Army, and unit readiness has suffered because of this fact. The deficiencies in the criteria lie in their encouragement of faulty supply practice rather than any failure to spotlight problem areas.

THE PRESCRIBED LOAD LIST READINESS INDICATOR

Only one part of the logistics section of the Unit Readiness Report is discussed here, namely, the unit stock of repair parts and maintenance-related items. Included is an outline of the evaluation criteria applied, a discussion of the major factors affecting the rating, and some of the deficiencies in the criteria.

Criteria

The criteria that determine the PLL indicator, or rating, in the Unit Readiness Report, are shown in the accompanying tabulation.

Percentage of PLL items at zero balance	Assigned REDCON rating
0-10	1
11-15	2
16-20	3
Over 20	4

Each quarter the unit reviews the status of its PLL stockage, determines the percentage of lines at zero balance, and enters the appropriate numerical value in block 65 of Form 2715 in accordance with the criteria shown above. Virtually all Seventh Army units have an assigned REDCAPE higher than 4 and should, theoretically, possess the resources to achieve corresponding readiness ratings. It will be recalled from Table 1, however, that the number of unit lines of stockage in zero balance was about 20 percent or higher on the

dates indicated. These data do not define the REDCON of any specific unit, but they do indicate that about half these units can be expected to report a rating of 4 in the PLL block.

A basic contradiction in the criteria arises from the fact that most Seventh Army units are authorized only a single stock of repair parts and are required by regulation to use this as a working stock in support of peacetime maintenance. The criteria cited above, however, are appropriate only for a special prescribed load of stock that is exempt from peacetime consumption and is reserved for use in the event of hostilities or other emergency conditions. As indicated earlier, a working stock that has no reserve or safety level will normally have a varying proportion of its items in zero balance. The actual average percentage of zero balances in a given unit is dependent on many factors.

Average Zero-Balance Condition

The average number of lines at zero balance in a unit's PLL stocks depend primarily on the volume of demand, the demand accommodation of the list, and the stock-replenishment time. The volume of demand depends on the nature of the unit, its peacetime-activity level, and the local maintenance practices. Demand accommodation reflects the quality of the PLL and depends on the general stockage policy and the performance of the stock records section. The average time and the associated distribution of the time to replenish stocks are functions of the performance of the unit and supporting DSSA in the processing of requests, the quality of stock management at the DSSA, and the condition of the supply system in general. These factors combine to determine the actual number of lines in zero balance. The percentage of lines in this condition, which is the quantity employed in assigning the REDCON rating, naturally depends also on the total number of lines carried on the PLL. A means is therefore provided to manipulate the zero-balance percentage and hence the rating.

The interrelation of most of these factors is illustrated qualitatively in Fig. 22. Time and facility limitations precluded quantitative analysis with any degree of accuracy. The figure plots the average number of lines at zero balance as a function of the percentage of DSSA initial fill for three levels of PLL demand accommodation. The parameters for each set of curves are the average unit replenishment times for initial fill at the DSSA and for fill of a request that is back-ordered by the DSSA. The relations were constructed on the basis of a crude linear approximation that assumes all replenishment times are equal to the average of the respective distributions, and that the number of zero balances created each day is equal to the product of the daily traffic matching the PLL and the percentage of demands for quantities equal to or greater than the authorized stockage quantity. Numerical values are shown in the figures merely to provide an appreciation of the approximate magnitudes involved and should not be interpreted as other than gross approximations. The total traffic assumed was 1000 requests/month, which is representative of a mechanized infantry battalion.

Figure 22 is based on replenishment-time parameters that are characteristic of current conditions.* It is not unusual for the percentage of initial

*RAC input to DA Board of Inquiry on the Army Logistic System, 15 October 1965-15 January 1966.

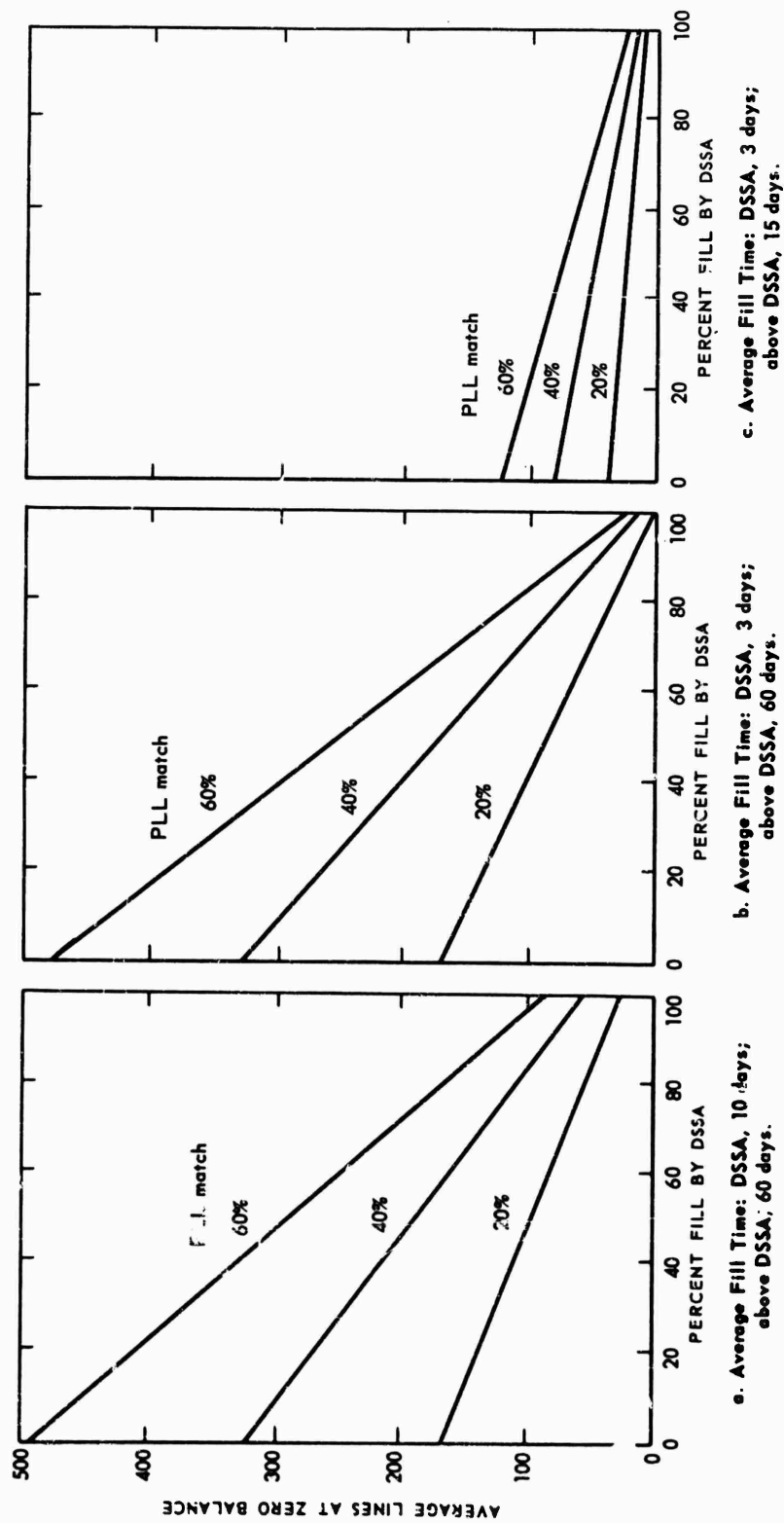


Fig. 22—PLL Zero Balances as a Function of Percentage of Fill by DSSA

fill provided by the DSSA to be on the order of 20 to 40 percent; in some cases it is even less than 20 percent. This is predominantly a reflection of current repair-parts shortages coupled with inadequate stock management at the direct-support level. Thus a unit with a good PLL in the sense of providing a high level of demand accommodation (60 percent) may well have 300 or more lines at zero balance as a normal operating condition, provided that the supplies are treated as a working stock and issue is unrestricted. As was indicated, an accommodation of about 54 percent could be expected from a PLL of 1400 lines under the conditions of the preferred stockage policy. For such a unit to achieve a REDCON rating as high as 2, for example, requires that there be fewer than 210 lines at zero balance. The unit cannot achieve this rating unless something like 70 percent initial fill of requests is accomplished by the supporting DSSA. Since very few DSSAs can achieve such performance, the unit is probably doomed to report a lower rating. If the initial DSSA fill is about 40 percent, for example, the unit may well have 300 lines at zero balance; it would require a minimum of 2000 lines in its PLL to report fewer than 20 percent zero balances. These additional 600 lines would have to be completely inactive if the zero balance were to remain unchanged. There is evidence that the makeup of the PLL has been manipulated to accomplish precisely this objective.

A more basic problem is revealed by the fact that a unit with an unresponsive PLL (i.e., low demand accommodation) has a better chance of achieving a satisfactory rating for a given number of line items carried in stock than does a unit with high demand accommodation. The criteria applied in evaluating the PLL not only fail to reflect the quality of the PLL as a list but actually favor the low quality list and thus do not provide an incentive to improve its quality. The objective of unit-supply management is to achieve a responsive stock list and to issue stocks as required for continuous-maintenance activity. In the context of short supply or long replenishment time, the unit has little incentive to do either, knowing that to do either only diminishes the chance of a REDCON rating corresponding to the assigned REDCAPE. In short, good supply performance at the unit is discouraged because of the nature of the criteria by which the unit is rated.

A further difficulty arises from the fact that the critical factors that govern the number of lines at zero balance are essentially beyond the control of the unit. Conceivably the unit can sharpen its processing of requests and vigorously pursue the replenishment stocks that are available from the DSSA so as to shorten the delay involved in obtaining initial fill of requests from the DSSA. The effect of diminishing this time is indicated in Fig. 22b. So long as the percentage of initial fill at the DSSA remains low and the back-order duration high, there is very little gain to the unit in terms of reducing the number of zero balances. The most effective direct control available to the unit is to restrict issue and to reduce the demand accommodation of the PLL. These actions are diametrically opposed to the desired supply performance.

Figure 22c indicates that when supply is plentiful and replenishment times are short, there will be a small number of zero balances independent of the DSSA fill percentage and PLL demand accommodation. In this context there is little penalty associated with high demand accommodation, but similarly there will be no indication of the quality of the list. If the responsive PLL

has few zero balances, the low quality PLL will have even fewer, and no requirement for corrective action will be indicated to the unit or higher commanders.

Faulty Supply Practices

There are indications of several faulty supply practices at unit level, some of which may be attributed to misguided attempts to circumvent the PLL indicator rating criteria. The major problems concern the reluctance to issue

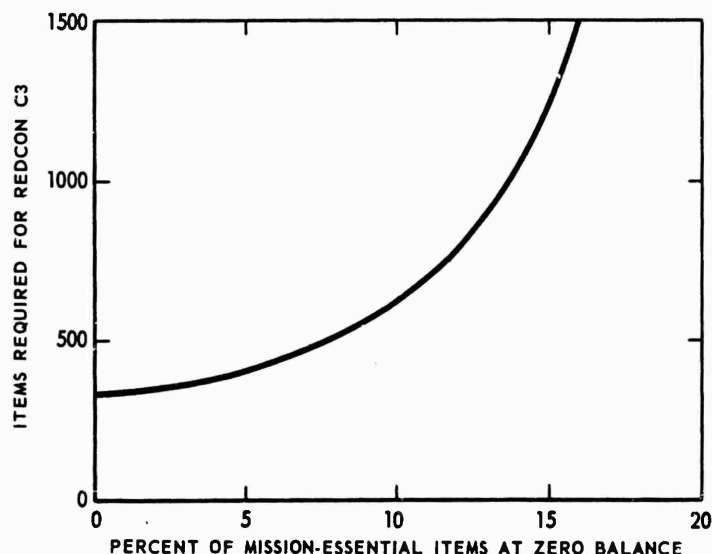


Fig. 23—Number of Mission-Essential Items Required To Achieve C3 in Block 65

Other Components		
Category	Lines	Percent at zero balance
Demand supported	400	38
Combat essential	500	18

parts for routine maintenance, acceptance of low demand accommodation, deferral of additions to stock and attempts to pad the PLL with low-usage items in an attempt to achieve a low percentage of zero balances. In addition the deletion of prescribed items has been encouraged in the event there is no stock on hand and replenishment appears uncertain. In sum the system causes units to concentrate on the reporting aspects of readiness rather than on readiness itself.

Examples of the indications mentioned previously appear in Tables 1 and 2. Fortunately the percentage of zero balances is computed and reported for

only a single point in time in each quarter. Issue restriction thus tends to be concentrated in the period just before the report is prepared, and additions to stockage are deferred until reporting is completed for the quarter. One reporting date for REDCON is 30 September. Referring again to the V Corps data in Tables 1 and 2, there is a sharp rise in both the zero balances and demand-supported lines of stockage just 1 month following the reporting date. The former indicates possible release of stock previously withheld, and the latter indicates possible deferral of stocklist additions. These practices have not been directly confirmed and, in fact, part of the increase in zero balances observed can be directly attributed to the addition of new stockage lines. Such practices are, however, certainly encouraged by the characteristics of the reporting criteria. The practice of enlarging the stock list with the objective of reducing the percentage (but not the number) of zero balances could well account for the wide divergence in the number of mission-essential items carried by the two Seventh Army corps.

The lack of notable success in reducing zero-balance percentages by additions to the stockage list can be attributed to the fact that the lines were not sufficiently inactive. The zero balances in the mission-essential lines range from 13 to 19 percent, so that little reporting benefit is derived from such stockage. Figure 23 illustrates the difficulty with an example of the number of mission-essential items that would be required to reduce the percentage of zero balances to 20 percent, as is required to score 3 in the PLL category of the REDCON indicator. The example assumes a PLL composed of 500 prescribed items having 18 percent zero balance and 400 demand-supported lines having 38 percent zeros. If the additional lines of stockage have no zero balances, only about 300 lines are required to report higher than condition 4. As the proportion of zero balance in the additional lines increases, the number of such lines rises quite sharply and becomes unlimited at a value of 20 percent. The hopelessness of such a practice is evident when the zero-balance percentage is similar to that of the mission-essential lines in V and VII Corps units.

REVISION OF THE PRESCRIBED LOAD LIST INDICATOR CRITERIA

It has been shown that the current criteria employed in evaluation of the PLL are deficient in two basic respects: they encourage faulty supply performance in the unit and they actually favor rather than identify a unit with a low-quality PLL that affords only marginal or inadequate demand accommodation. A possible solution to this dilemma is to revise the reporting criteria so that they retain the property of disclosing readiness deficiencies where they exist and at the same time encourage the desired performance at the unit.

A criterion that appears to meet the requirements outlined above is provided by the overall percentage of requests that are given immediate fill from unit PLL stockage (suggested by Mr. Hoppes of the RAC/McLean office). This percentage is limited by two factors—PLL accommodation and average stock balances on hand—and is a direct measure of the degree to which the unit supply section is performing its intended function. If repair parts are in short supply, the proposed criterion will surely reflect the fact. Even if supply is plentiful, however, the fill percentage cannot be satisfactory unless the

stockage is responsive to the requirements of the unit. The needed data could be collected on a simple tally sheet kept by the stock clerk or by notations on the transaction register. The percentage could be computed monthly for review by the unit commander and consolidated quarterly for use in the readiness report. These data concern continuing performance as opposed to the status at an isolated point in time and would be of great value to the unit commander in assessing the performance of his supply section.

Although the principle is considered sound, the details of the appropriate relation between overall percentage of unit fill and the numerical REDCON rating have not been worked out in this study. As pointed out previously, the demand accommodation of the PLL is the upper bound on the fill percentage that can be achieved, and it is not economical to strive for an accommodation much in excess of 60 percent. The target value of fill percentage would of course be less than this value, since some demands will inevitably encounter zero balances even under conditions of plentiful supply and good stock management at all echelons in the supply system.

Another possible approach is to consider the employment of a special-purpose prescribed load of repair parts in addition to the normal working stock. This special stock would be exempt from peacetime issue and be reserved for use during combat. Such loads are authorized in AR 735-35¹ at the discretion of the major commander. It is interesting to note that the present criteria for the PLL indicator would be entirely appropriate for such a special-purpose stock. An indicator like that proposed above should be applied to the working stock, however, to prevent deterioration of the unit peacetime supply performance.

In any event a revision of the current criteria would be generally beneficial, and serious consideration should be given to an extra load of prescribed items to enhance the ability of the unit to maintain its equipment in an operable condition during periods of independent operation. The investment required for such an action is not accurately known, but if the dollar value of the prescribed items of a mechanized infantry battalion (about \$13,000) were considered typical, the total for Seventh Army would be approximately \$10 to \$15 million.

Chapter 8

PRESCRIBED LOAD LIST STANDARDIZATION AND CENTRAL MAINTENANCE

The subject of PLL uniformity and the possibility of PLL standardization has received considerable attention recently, both within Seventh Army and at higher levels. It is the purpose of this chapter to review some of the possibilities in this regard and to comment on their relative merits. Two basic degrees of standardization are identified and defined, some characteristics of standardized PLLs are discussed, and finally the merits of central PLL maintenance are considered. Standardization and centralization are discussed together since full standardization implies the requirement of central generation and maintenance of the PLL at a level above the unit. In contrast to this situation, it is possible to provide central PLL maintenance without requiring that the PLLs be standardized.

BASIC AND STANDARD PRESCRIBED LOAD LISTS

Two fundamental types of standardization with respect to the PLL can be distinguished. The distinction is made on the basis of completeness and the responsibility for constructing and updating the list with regard to additions, deletions, stockage quantity adjustment, and stock number changes.

Basic Prescribed Load List

A basic PLL defines a minimum set of line items to be stocked in each of a group of like units but does not establish the complete PLL of any unit. A minimum stockage quantity may be specified but is subject to individual upward adjustment by the unit. A basic PLL thus constitutes a partial standardization of the stockage in the group of units to which it is applied. With such a PLL, the responsibility for the recording of demands, the addition of items qualifying for stockage, and the determination of the authorized quantity of stockage remains with the unit.

The most immediate example of a basic PLL is of course the set of prescribed items listed in the technical manuals covering the mission-essential equipments in the unit. (The preferred policy identified above thus utilizes a basic PLL as the essential core of the PLL.) Units with the same TOE would necessarily have essentially the same basic set of prescribed items in their

PLL. In a group of infantry battalions, for example, this would provide about 750 common lines in the absence of any further commonality that might result from concurrent repair parts for equipment introduced simultaneously in the group.

The most significant aspect of the basic PLL is that it does not relieve the unit of responsibility for demand recording or any of the functions associated with reviewing and updating its PLL. It will be useful to the unit in maintaining its PLL, but it does little to reduce the workload at the unit level.

Standard Prescribed Load List

In contrast to the basic PLL, a standard PLL is defined here as comprising a complete list of the items, with authorized quantity, to be stocked by two or more units having the same TOE. Since the standard list defines all lines to be carried in the unit together with the stockage quantity for each, it must be constructed and updated at a level above the units to which it is applied. The demand data from each unit must be accumulated and processed by a central facility having adequate data-processing capabilities. For example, a standard mechanized infantry battalion PLL might be prepared at division level and applied to all such battalions within the division. With the possible exception of a few repair parts applying to equipment unique to a particular battalion, the items and quantities would be identical in each unit's PLL. A standard PLL thus provides the ultimate in PLL uniformity. It does not, however, necessarily provide the ultimate in economical demand accommodation.

There are indications that standardization may lead to unnecessary compromise in the selection of demand-supported augmentation stockage. The data in Fig. 8 illustrate this point. The accommodation curve representing 42 battalion-months of experience is derived from the consolidated demand history of seven mechanized infantry battalions over a period of 6 months. The curve representing 6 battalion-months is the history of one of these battalions for the same period. If a predetermined demand accommodation level is selected, say 60 percent, it is seen that over 1200 line items (12 percent of 10,501 active items) were required to provide this overall accommodation of the consolidated demands. This same level of demand accommodation (60 percent) was provided in the single battalion by somewhat fewer than 800 line items (26 percent of 2952 active items). This example merely points up a possible source of difficulty in selecting a single set of line items to accommodate the peacetime demands of each of a group of like units. These data are after the fact, however, and do not represent the relative predictive performance of actual standard and tailored PLLs. Definitive results should become available as a result of a test of the concept of central PLL maintenance that is currently in progress at the 3d Inf Div.

A distinguishing feature of the standard PLL is that it relieves the unit of responsibility for the accumulation of demand data and maintenance of its list. The fringe demand file is eliminated, as is the monthly review of all PLL items, which includes the recomputation of the authorized quantity and the identification of those parts that are to be deleted. Also eliminated are the review of each fringe request to determine if the part qualifies for stockage and, if it does, the determination of the authorized quantity and the preparation of a request for stockage authorization.

The standardization of PLLs is attractive from the standpoint of simplifying the units' supply procedures in an area in which they have been notoriously unsuccessful in the past. Provision of periodically updated PLLs for battalions within a division would leave the unit supply personnel free to concentrate their attention on maintaining accurate records of stock on hand, the issue and receipt of materiel, and the necessary daily preparation of requests to the DSSA together with follow-up on outstanding requisitions. Another feature of merit would be the knowledge of each unit of the stockage of other like units, which would facilitate the exchange or cross-leveling of supply in the event of emergency conditions such as equipment deadlined for parts.

It should be emphasized, however, that the adoption of a set of standard PLLs within a division is not the only way to achieve the advantages cited above. At no essential increase in effort, centralized construction and maintenance of individual tailored PLLs could be provided for each unit, since the data that must be accumulated for standard PLLs are identical to those required to prepare tailored PLLs for individual units.

There are two major potential benefits from centralized stock management within a division: reduction in unit workload and improvement in the accuracy and efficiency of supply data processing in the division. The simplification of unit supply procedures as outlined is obtained regardless of the choice of standardized or tailored PLLs so long as the PLL is provided to the unit by a higher echelon. The potential increase in efficiency derives from the fact that current resources and hence current procedures require that essentially the same data be collected and processed at two and frequently three distinct echelons within the division. Given automatic data-processing capability of even a rudimentary sort, a central division demand file could be maintained. These data could then be sorted and processed to provide the basic input for the development and maintenance of division unit PLLs, forward support company ASLs, and finally the division ASL maintained in the main support company in accordance with the Reorganization Objective Army Division (ROAD) organization and supply concept outlined in FM 5-30.⁸ Obviously a great many details have been omitted in this discussion. To consider the problem in appropriate detail would require a study the size of this one. Suffice it to say that the concepts outlined above are being tested in the 3d Inf Div (along with other related procedures involving the ROAD supply concept) and the promise of improvement is sufficient to warrant continued support and close scrutiny by Seventh Army.

CENTRAL MANAGEMENT OF DIVISION STOCKAGE LISTS

The purpose here is merely to record some qualitative observations on the concept of centralized generation and maintenance of unit PLLs and ASLs of the forward and main support companies of a division. A detailed consideration of this concept is well beyond the scope of this study, which has been restricted to consideration of procedures that are feasible with present resources. Central management of stockage lists and other related revisions of supply procedure will require the general availability of data-processing equipment beyond that currently authorized. A follow-on study is planned that will treat the problem of repair parts stock management within the division.

As mentioned, the introduction of standardized PLLs implies the requirement for a central data-processing facility and control of the list composition at a level above that of the individual units. The essential feature is centralized management, not standardization. Given the facilities and data required, standardization and tailored PLLs are equally feasible. The difference becomes one of the manner in which the data are grouped for analysis.

The feasibility of centralized PLL management has been partly demonstrated in a program under way at the 3d Inf Div. Standardized PLLs are currently being provided for the infantry, armored, and artillery battalions of the division. Electronic accounting machine (EAM) equipment has been made available to the division by Seventh Army and a test of the concept is in progress that includes preparation and maintenance of the forward and main support company ASLs in addition to the unit PLLs mentioned. Ultimately it is planned to provide a PLL service for all units within the division.

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Appendix A

DEFINITIONS

The following set of definitions is included for reference. Official definitions extracted from Army regulations are identified by the number of the regulation from which they are quoted. Definitions without reference are those of the authors and have no official status.

Prescribed Load (AR 711-16).⁵

That quantity of combat-essential supplies and repair parts (other than ammunition) authorized by the major commanders, as directed within criteria established by Department of the Army and AMC publications for Classes II and IV, to be on hand in units and which is carried by the individuals or on the unit vehicles to enable the unit to sustain itself until resupply can be effected (normally 15 days' level). Classes II and IV are designed for combat requirements and will be supplemented for peacetime operations as required by adding high-mortality items that do not fall in the category of combat essential items. The quantity of Classes I and III are established by the major commanders. The prescribed load is continually reconstituted as used.

Prescribed Load List (AR 735-35).¹

The prescribed load list, DA Form 2063-R, is a document which indicates those quantities of repair parts and maintenance-related items required to be on hand at user level. Normally, this is considered to be 15 days of supply. The PLL will consist of the following:

1. Items designated in appropriate technical manuals or 7-8 series manuals for initial stockage to support the unit or organizational maintenance capability for assigned equipments.
2. Any additional repair parts and maintenance related expendable supplies which have generated sufficient demands to qualify for stockage.

Prescribed Items. The repair parts and maintenance-related items designated in the 20P Department of the Army Technical Manuals (DATMs) and 7-8 series manuals and identified by an authorized stockage quantity or an allowance factor, from which the authorized stockage quantity may be computed. The authorized stockage quantity is given as a function of end-item density and may be zero. This term is employed here to designate those items from which the initial stockage is selected, as referred to in the definition of the PLL. The prescribed items are those designated as combat-essential and high-mortality items in DATMs published before August 1965.

Combat-Essential Repair Part (AR 700-18³ and AR 320-5).⁶

A functional repair part which is essential for the maintenance of a combat-essential end item or system in a state of combat readiness. Normally a combat-essential repair part is expected to have a higher mortality rate under combat conditions and therefore must be stocked at designated echelons in a minimum quantity of at least one, regardless of demand experience. Specific items will be as designated in the Repair Parts and Special Tool Lists of the appropriate technical manuals.

This term is apparently going out of style. The current editions of AR 700-18³ and AR 735-35¹ no longer contain this term, although earlier editions used it and it is defined essentially as above in DATMs published as late as July 1965. The initial stockage items referred to in the latest definition of the PLL include those items now designated in many DATMs as combat essential. The initial stockage items, however, include also a group of items now designated as high-mortality items in the technical manuals. Presumably this distinction will tend to disappear as new manuals are published and the old ones are revised according to the instructions appearing in the new edition of AR 700-18.³ In the future there will be a single group of prescribed items designated in the DATMs by the presence of a quantitative allowance.

High-Mortality Item (TM 9-2300-223-34P).⁹ "A repair part for which the anticipated or actual mortality is 30 or more failures per 100 equipments per year. High mortality parts are normally stocked at the category of maintenance authorized to replace the part."

Demand-Supported Item (Augmentation Item). An item other than an initial stockage item that is authorized for replacement at unit level and that qualifies for stockage as PLL augmentation on the basis of demand frequency. In Seventh Army, for example, an item qualifies for stockage if it receives three demands in 180 days and remains qualified so long as it continues to receive at least one demand each 180 days.

Concurrent Repair Parts (Concurrent Spares) (7A Reg 735-2).¹⁰

Repair parts procured concurrently with end items which are new to the Army supply system. Provides the system with those parts necessary for initial distribution and maintenance between initial end-item delivery to the user and the time that supply records are sufficiently established to permit procurement by normal replenishment methods.

Mission-Essential Repair Part (7A Reg 735-2).¹⁰ "An item which does not qualify for stockage under the categories defined above (prescribed items, demand-supported items, concurrent repair parts) but which is essential to the organizational mission."

At the organizational level, this category of stockage is peculiar to Seventh Army. It is not recognized as a legitimate category in the DA regulations. Mission-essential parts are designated by the unit commander and, on approval of the supporting DSSA, may be stocked in a quantity of one.

Standard PLL. A complete PLL designed for use by more than one organization or unit of the same type, generated and maintained at a level above that of the units to which it is applied. The standard PLL specifies both the items to be stocked and the authorized stockage quantity for each item. The

items and quantities are identical for each unit with the possible exception of repair parts for equipment unique to a unit, such as a particular mode. A standard PLL relieves the unit of responsibility for the accumulation of demand data and for the documentation and periodic review of the list. A standard PLL is distinguished from a basic PLL as defined below.

Basic PLL. A basic PLL is a list that defines a minimum set of items to be stocked in each unit of a group to which it is applied but does not establish a complete PLL for any unit and does not specify the authorized stockage quantity. A minimum retention quantity may be specified, however. Responsibility for PLL maintenance remains with the unit in accordance with the current regulations. The list of initial stockage items for the equipment of a TOE unit constitutes an example of a basic PLL.

Functional Repair Parts (7A Reg 735-240).¹¹ "Repair parts which are essential to the continuous operation of an end item of equipment and which, upon failure, will deadline the item."

Maintenance-Related Item. Maintenance-related items include those items and supplies, not a part of or a design feature of the end item itself, used in performing maintenance on an end item. Examples include sandpaper, cleaning and preserving materials, and welding rods.

Initial Stockage Items. Those repair parts and maintenance-related items on the prescribed-items lists in the technical manuals that qualify for inclusion on the PLL in specified quantities on the basis of end-item density in a particular unit. They constitute the minimum essential items on the PLL for all like units (see "Basic PLL").

Appendix B

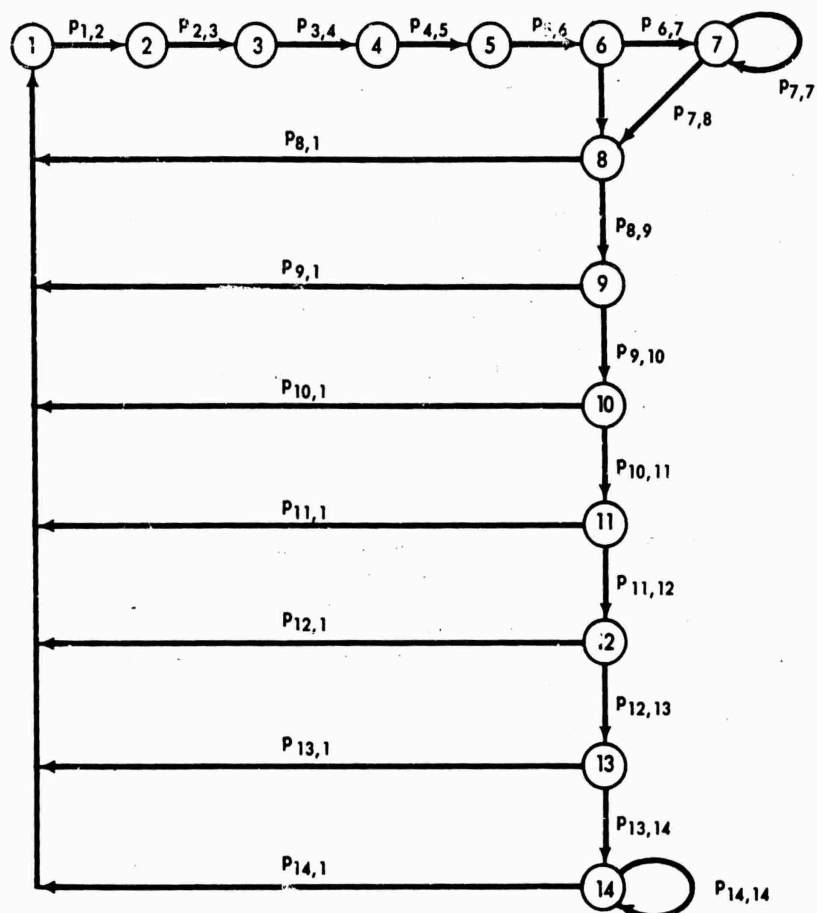
A MODEL OF THE PRESCRIBED LOAD LIST STOCKAGE PROCESS

With some simplifying assumptions, a simple Markov model of the PLL stockage process can be constructed. The primary assumptions required are that (a) demands for a given repair part are generated by a Poisson process, (b) demand rates are constant, and (c) additions to and deletions from the PLL occur at discrete, uniform intervals. None of these assumptions is strictly true, but it is considered that useful comparisons of alternative stockage criteria can be made.

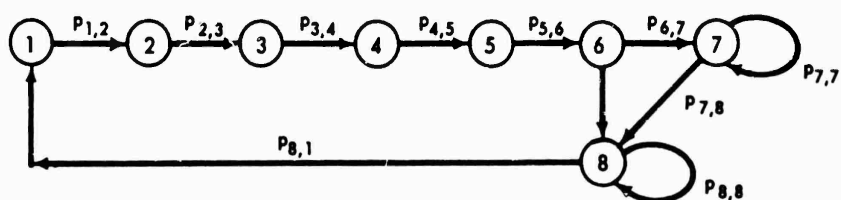
The purpose here is merely to estimate the steady-state size of the demand-supported component of the PLL, the turnover rate, and the net PLL size that would result from the application of the alternative policies examined in the study. The assumption that additions to the PLL occur at the PLL review interval (30 days) permits the use of a finite, discrete-time Markov process to represent the system. The assumption of Poisson demand generation greatly facilitates the derivation and evaluation of the transition probabilities. Restriction of the investigation to steady-state properties and the sparseness of the transition-probability matrix result in simple algebraic expressions that are readily evaluated. The model output is in the form of single-item properties expressed as a function of the item-demand rate. The combination of these properties with the known distribution of demand rate among the items active in a given type of unit produces the desired estimates of PLL component size and turnover rate.

SINGLE-ITEM MODEL

Two sets of stockage criteria are considered here—those currently in use at Seventh Army and those recommended by the DA in AR 735-35.¹ In both cases an item that is demanded three times within a period of 180 days qualifies for addition to the PLL. The addition is to be made at the time of occurrence of the third demand so that, strictly speaking, the addition process is continuous in time. An item that is on the PLL is reviewed each 30 days and is thus subject to deletion at discrete intervals. Seventh Army criteria require that an item be deleted from the PLL if no demands have occurred in the 180 days preceding the date of review. DA regulations are more stringent and require that an item be deleted if fewer than three demands have occurred in the



Seventh Army Stockage Criteria



DA Stockage Criteria

Fig. B1—Transition Diagrams for the PLL Stockage Process
with Alternative Stockage Criteria
See following section "Transition Probabilities."

180 days preceding the review date. Because an item that is added to the PLL is guaranteed a minimum tenure of six review periods (180 days), it is considered reasonable to make the simplifying assumption that additions are also made at discrete 30-day intervals, regardless of the actual date within the interval on which the qualifying demand occurred.

Transition diagrams corresponding to the two sets of criteria are shown in Fig. B1. Circles represent the possible states for an item with respect to stockage, and the directed paths represent transitions from one state to another or a return to the same state. Transitions occur at 30-day intervals (i.e., at the end of each review period). The formulation of the model given here generally follows that outlined in the first chapter of Ronald A. Howard's Dynamic Programming and Markov Processes.¹²

In the model of the Seventh Army stockage process there are 14 distinct states whereas in the DA model there are only 8. The states are defined in terms of PLL status (on/off) and the time since the last change in PLL status. State definitions for each case are shown in Table B1.

TABLE B1
Comparison of Seventh Army and Department of the Army
State Definitions

State	Seventh Army stockage criteria		DA stockage criteria	
	PLL status	Days since PLL status change	PLL status	Days since PLL status change
1	On	< 30	On	< 30
2	↑	< 60	↑	< 60
3		< 90		< 90
4		<120		<120
5		<150		<150
6	↓	<180	↓	<180
7	On	≥180	On	≥180
8	Off	< 30	Off	≥ 0
9	↑	< 60		
10		< 90		
11		<120		
12		<150		
13	↓	<180		
14	Off	≥180		

For both Seventh Army and DA states 1 through 7 correspond to item stockage; an item in other states is not on the PLL. The multiple nonstockage states in the case of Seventh Army criteria result from the fact that given state 8, it is certain that no demands have occurred in the previous 180 days. Transition from state 1 through intermediate states to state 6 is certain because no item is deleted until at least 180 days have elapsed. States 7 and 14 in the Seventh Army model and states 7 and 8 in the DA model are the only re-entrant states. In either version of the model, unique limiting state probabilities

exist. The processes are completely ergodic since the number of possible states is finite and each state is accessible from all other states. Accessibility follows from the fact that all transition probabilities are positive as a result of considering only items with positive demand rates.

Transition Probabilities

To introduce some notation, let S_i be the limiting steady-state probability that an item is in state i , and let p_{ij} be the probability of transition from state i to state j . $P(x/y)$ denotes the probability of the event (x/y) where x is the number of demands that occur and y is the associated period of time measured in days. For example, $P(0/30)$ is the probability of no demands in 30 days.

In terms of the notation indicated above the transition probabilities may be written as shown below and readily evaluated from tables of the Poisson probability function at a mean equal to the product of the preselected demand rate and the time period associated with the event.

Seventh Army Stockage Criteria.

$$\begin{aligned}
 p_{1,2} &= p_{2,3} = p_{3,4} = p_{4,5} = p_{5,6} = 1 \\
 p_{6,7} &= P(>0/180) & p_{6,1} &= 1 - p_{6,7} \\
 p_{7,8} &= P(>0/30)P(0/150)P(0/30)/P(>0/180) & p_{7,7} &= 1 - p_{7,8} \\
 p_{8,9} &= P(<3/30) & p_{8,1} &= 1 - p_{8,9} \\
 p_{9,0} &= P(<3/60)/P(<3/30) & p_{9,1} &= 1 - p_{9,10} \\
 p_{10,11} &= P(<3/90)/P(<3/60) & p_{10,1} &= 1 - p_{10,11} \\
 p_{11,12} &= P(<3/120)/P(<3/90) & p_{11,1} &= 1 - p_{11,12} \\
 p_{12,13} &= P(<3/150)/P(<3/120) & p_{12,1} &= 1 - p_{12,13} \\
 p_{13,14} &= P(<3/180)/P(<3/150) & p_{13,1} &= 1 - p_{13,14} \\
 p_{14,14} &= P^2(<3/30)P(0/150) + P^2(<2/30)P(1/150) \\
 &\quad + P^2(0/30)P(2/150)/P(<3/180) \\
 p_{14,1} &= 1 - p_{14,14}
 \end{aligned}$$

DA Stockage Criteria.

$$\begin{aligned}
 p_{1,2} &= p_{2,3} = p_{3,4} = p_{4,5} = p_{5,6} = 1 \\
 p_{6,7} &= P(>3/180) & p_{6,8} &= 1 - p_{6,7} \\
 p_{7,8} &= P(>2/30)P(0/150)P(<3/30) + P(>1/30)P(1/150)P(<2/30) \\
 &\quad + P(>0/30)P(2/150)P(0/30)/P(>2/180) \\
 p_{7,7} &= 1 - p_{7,8} \\
 p_{8,1} &= p_{7,8} P(>2/180)/P(<3/180) \\
 p_{8,8} &= 1 - p_{8,1}
 \end{aligned}$$

Limiting-State Probabilities and Derived Quantities

The limiting-state probabilities S_i are readily derived from the fact that $\tilde{S} = \tilde{S} \| p_{i,j} \|$, where \tilde{S} is a row vector whose elements are S_i , and $\| p_{i,j} \|$ is the transition matrix, and from the additional fact that $\sum_i S_i = 1$. These relations generate a set of algebraic equations that may be solved for the S_i in terms of the transition probabilities $p_{i,j}$. The limiting-state probabilities and derived expressions for the probability that an item is on the PLL and the turn-ins per item per month are listed below for the Seventh Army and DA versions of the model.

Seventh Army Criteria.

Let

$$\begin{aligned} \theta = & (7 + p_{6,7}/p_{7,8} + p_{8,9} + p_{9,10}p_{8,9} + p_{10,11}p_{9,10}p_{8,9} \\ & + p_{11,12}p_{10,11}p_{9,10}p_{8,9} + p_{12,13} \cdots p_{8,9} \\ & + p_{13,14} \cdots p_{8,9}/p_{14,1}) \end{aligned}$$

then

$$S_1 = S_2 = S_3 = S_4 = S_5 = S_6 = \theta^{-1}$$

$$S_7 = p_{6,7}/p_{7,8} S_6 = p_{6,7}/p_{7,8} \theta^{-1}$$

$$P_o = \text{probability that an item is on the PLL}$$

$$= \sum_{i=1}^7 S_i = (6 + p_{6,7}/p_{7,8}) \theta^{-1}$$

$$T = \text{turn-in (deletion) rate per item per month (30 days)}$$

$$= p_{6,8} S_6 + p_{7,8} S_7 = \theta^{-1}$$

DA Criteria.

Let

$$\theta = 6 + p_{6,7}/p_{7,8} + 1/p_{8,1}$$

then

$$S_1 = S_2 \cdots = S_6 = \theta^{-1}$$

$$S_7 = p_{6,7}/p_{7,8} \theta^{-1}$$

$$P_o = \text{probability that an item is on the PLL}$$

$$= \sum_{i=1}^7 S_i = 1 - S_8 = (6 + p_{6,7}/p_{7,8}) \theta^{-1}$$

$$T = \text{turn-ins (deletions) per item per month (30 days)}$$

$$= p_{6,8} S_6 + p_{7,8} S_7 = \theta^{-1}$$

MODEL OUTPUT

The probability that an item is included in the PLL has been evaluated at several values of demand rate and the results plotted in Fig. B2. The effect of the stringent DA deletion criteria is readily apparent. The estimates of the

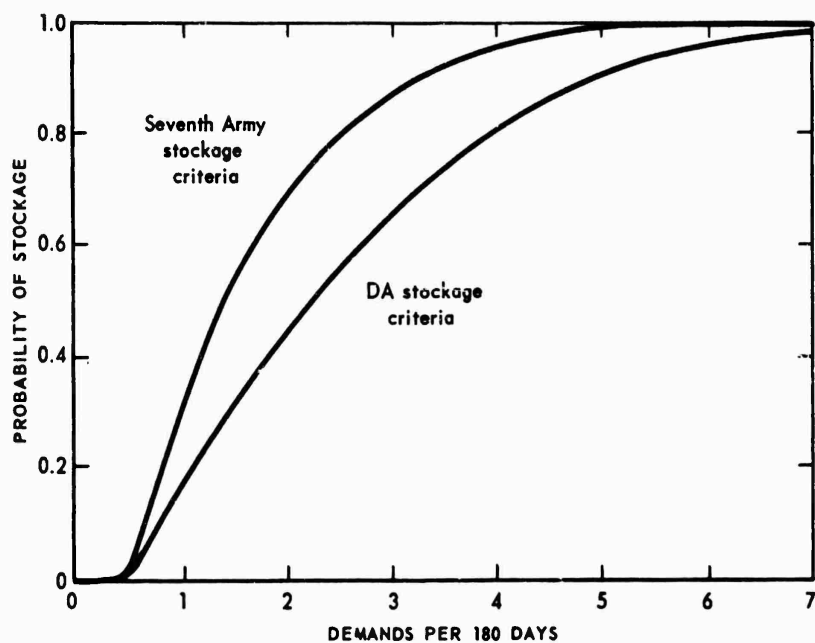


Fig. B2—Probability of Stockage under DA and Seventh Army Stockage Criteria

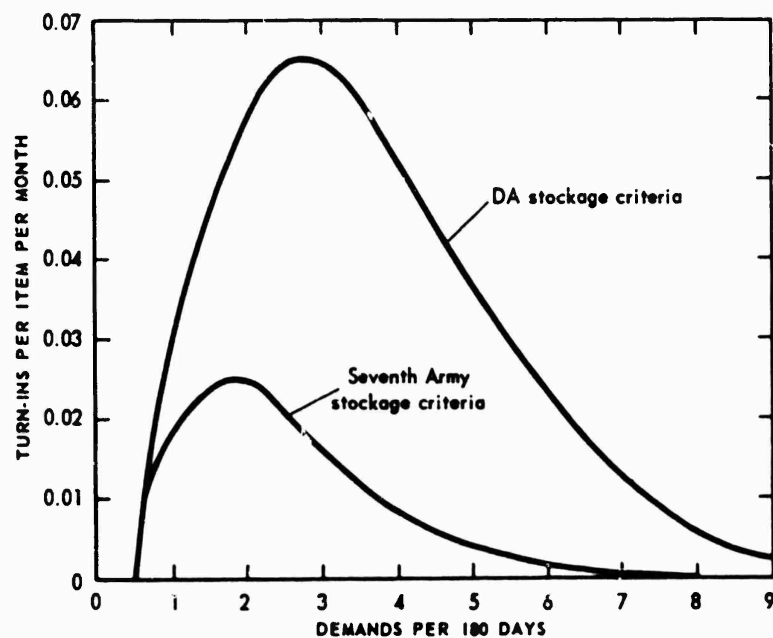


Fig. B3—Turn-ins per Item per Month as a Function of Demand Rate

demand-supported component sizes given in Table 6 were obtained by assuming that the number of items in each frequency group (Table 4) approximates the proportion of items having a demand rate corresponding to the observed frequency. The sum of the products of the number of items in each frequency group and the probability of PLL inclusion evaluated at the corresponding demand rate gives an estimate of the expected number of items included in the PLL as a steady-state condition.

Figure B3 compares the turn-in (deletion) rates resulting from application of the alternative stockage criteria. The turnover rate is just twice this value since it is assumed that the PLL is in a steady-state condition in which additions balance deletions. The expected number of additions and deletions and hence the turnover as a percentage of the total was determined in a manner analogous to that by which the expected PLL size was determined.

VERIFICATION OF THE POISSON ASSUMPTION

To provide an indication of the validity of the assumption that demands can be considered to be generated by a Poisson process, the expected number

TABLE B2
Number of Items Demanded N or More
Times in a Single Battalion
(180-day period)

N	Observed (average over seven bns)	Computed (Poisson probabilities)
1	2732	2814
2	839	993
3	530	520
4	340	313
5	234	208
6	174	170

of items experiencing N or more demands in a single battalion was computed using Poisson probabilities for the appropriate values of N. The results of this check are tabulated in Table B2 and shown in more detail in Fig. B4. The agreement is considered sufficiently good to justify use of the Poisson assumption for the purposes of this study.

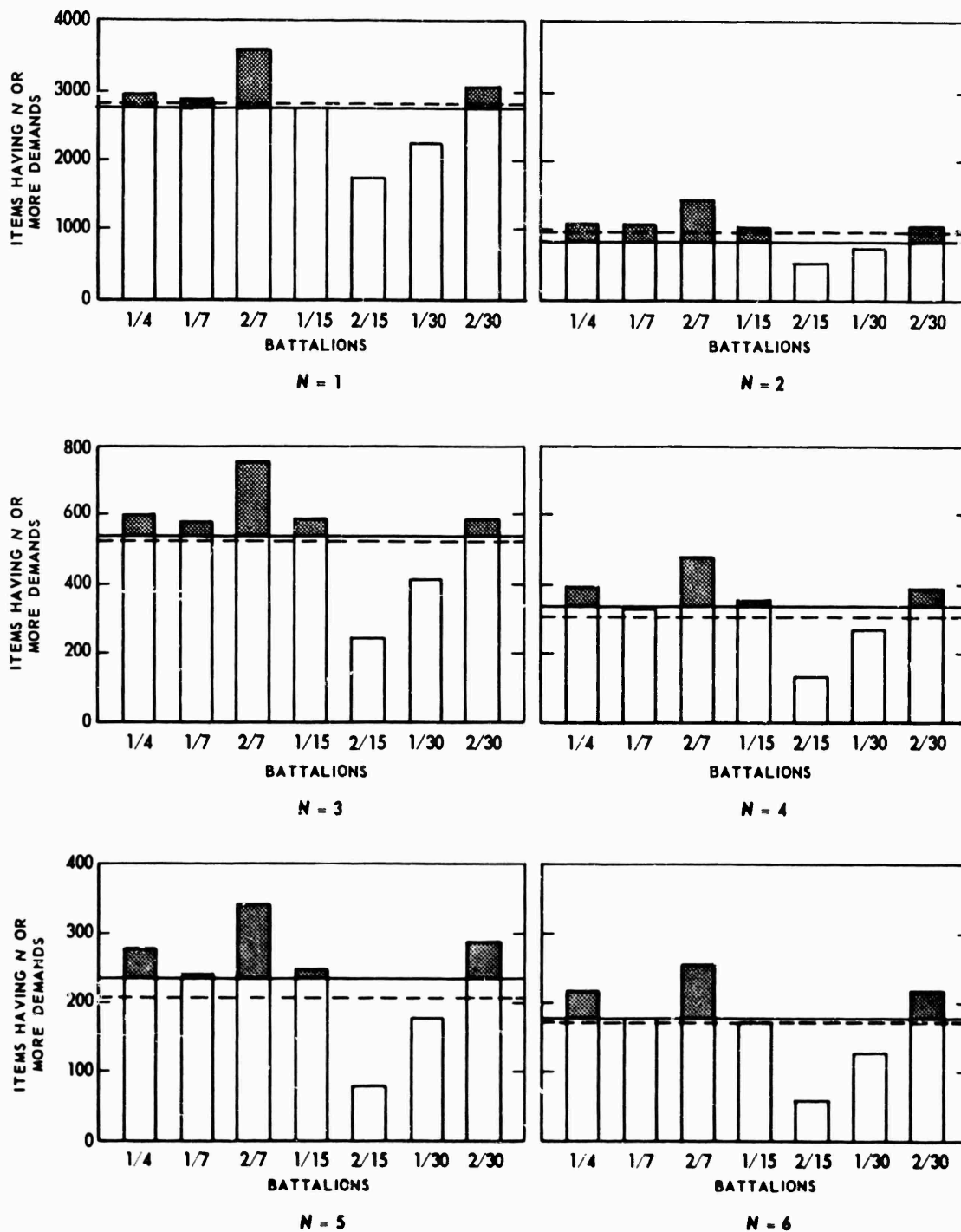


Fig. B4—Comparison of Computed and Observed Values for the Number of Items Demanded N or More Times

— Observed average — Computed average

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